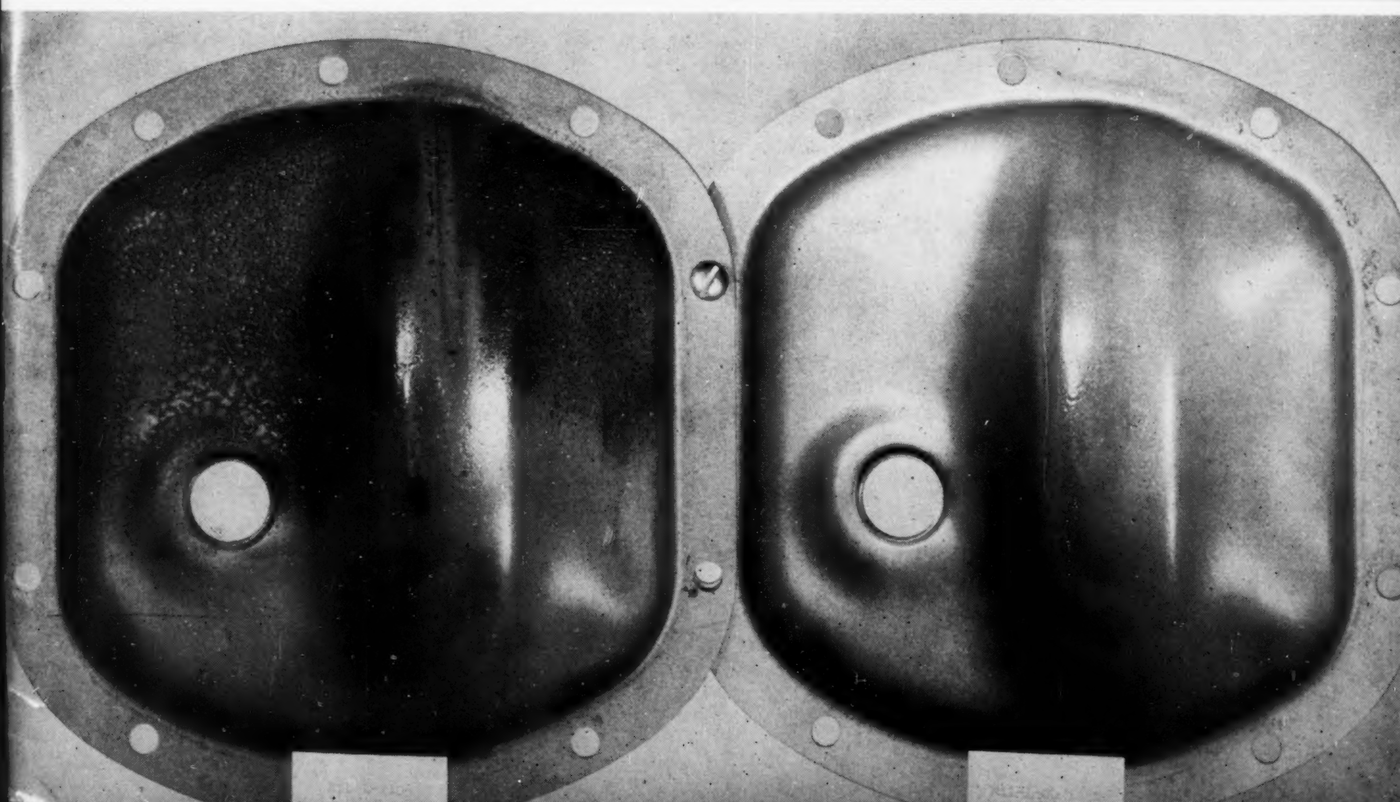
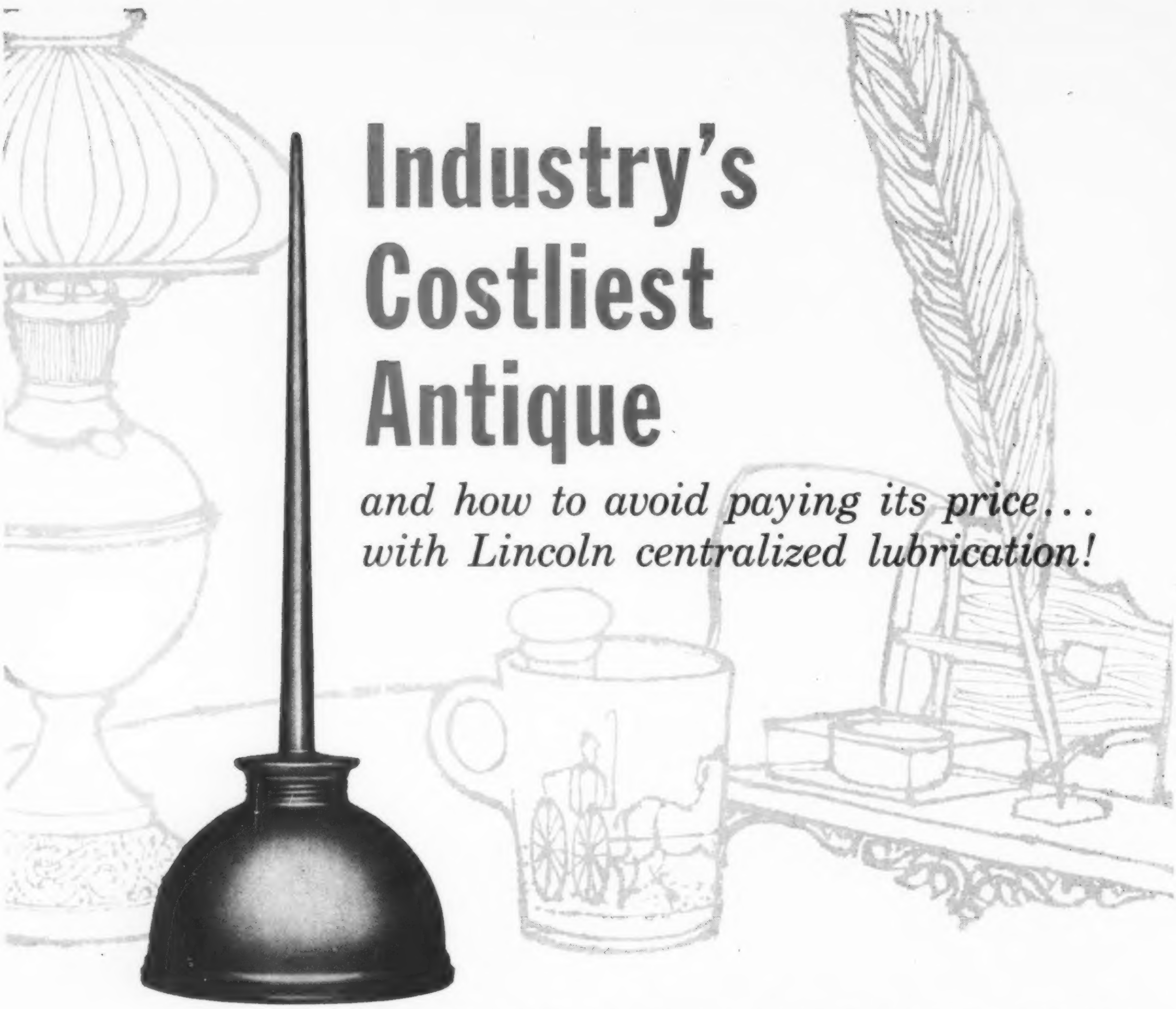
march, 1960

nlgi spokesman

journal of the national lubricating grease institute





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IN THIS ISSUE

THE COVER

THIS photo illustrates the degree of moisture corrosion protection afforded by two multi-purpose gear lubricants, in a test developed by Armour Research Foundation under contract with the United States Ordnance Department. In their article, "The 'New Look' in Automotive Axle Gear Lubricants," presented at the 12th annual IOCA meeting, E. P. Cunningham and D. W. Dinsmore report on recent developments in gear lubricants and describe results of field tests conducted by the Ordnance Department to establish a basis for the preparation of new specifications.

NLGI PRESIDENT'S PAGE

By H. A. MAYOR, JR., *President*

Technical Committee Continues To Make Big Contribution To Institute Progress

Those were big shoes vacated by Ted Roehner when he stepped down from Technical Committee leadership but they are being more adequately filled every day by his ambitious successor, Larry Brunstrum.

If every NLGI member could see the volume of paper work generated by each of the hard-working Technical Committee members, you should be impressed indeed with the total effort involved. In the short time Larry has occupied this important Institute office, he has:

—completed the re-organization of the entire Technical Committee (see new manning charts elsewhere in this issue).

—charged each sub-committee chairman and his members with important 1960 objectives and goals.

—laid solid ground work for the continuing, important Technical committee participation in our Annual Meeting programs.

Our hats off to you Larry, and your hard-working cohorts. Keep up the good work!

H. A. MAYOR, JR.
President

Future Meetings

MARCH, 1960

15-17 SAE National Automotive Meeting, Sheraton-Cadillac Hotel, Detroit.

23-24 Ohio Petroleum Marketers Assn., Annual Convention and Marketing Exposition. Deshler-Hilton Hotel, Columbus, Ohio.

APRIL, 1960

19-20 ASLE, Annual Meeting and Exhibit, Netherland—Hilton Hotel, Cincinnati.

20-22 API Division of Production, Rocky Mountain District Meeting, Gladstone, Henning, & Townsend Hotels, Casper

20-21 National Petroleum Association Spring Meeting, Sheraton Cleveland Hotel, Cleveland, Ohio.

MAY, 1960

16-17 API Division of Marketing, lubrication committee meeting, Bedford Springs Hotel, Bedford Springs, Pa.

18-20 API Division of Marketing Midyear Meeting, Statler-Hilton Hotel, Cleveland

JUNE, 1960

5-10 Society of Automotive Engineers, summer meeting, Edgewater Beach Hotel, Chicago

SEPTEMBER, 1960

14-16 National Petroleum Association Annual Meeting, Hotel Traymore, Atlantic City, New Jersey.

18-21 ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans.

18-20 IOCA 13th Annual Meeting, Hotel Moraine, Highland Park, Ill.

OCTOBER, 1960

17-19 ASME – ASLE Lubrication Conference, Statler Hilton Hotel, Boston.

OCT. 30-NOV. 1 NLGI Annual Meeting, Edgewater Beach Hotel, Chicago

NOVEMBER, 1960

3-4 SAE National Fuels and Lubricants Meeting, Mayo Hotel, Tulsa, Okla.

27-Dec. 2 ASME Annual Meeting, Statler Hilton Hotel, New York.

1960 Report—
How Baragel* and Baragel* 24 improve grease efficiency

BARAGEL extends versatility as a non-soap gelling agent

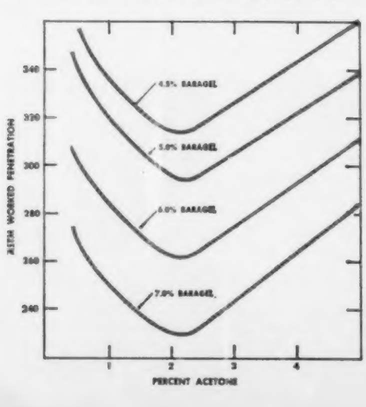
Among the non-soap gelling agents used by grease compounders, BARAGEL has been coming to the fore as a versatile gelling material. Lubricating greases made with this product of Baroid Chemicals, Inc., show practically no change under extremes of heat, cold or moisture.

Technically, BARAGEL is a reaction product of mixed organic ammonium halides and refined sodium montmorillonite. A common organic antioxidant is included in the reaction mixture to provide built-in oxidation inhibiting properties.

As its chemical nature indicates, BARAGEL is a member of the BENTONE* family of products. BENTONE 34 has been outstandingly successful in lubricating greases, paint, plastics, inks and other fields. Experience indicated that even further efficiency could be achieved by tailoring the product to suit a specific application. BARAGEL is the result of research directed to make the product meet the needs of the lubricating grease industry.

BARAGEL efficient in greases made with high VI oils

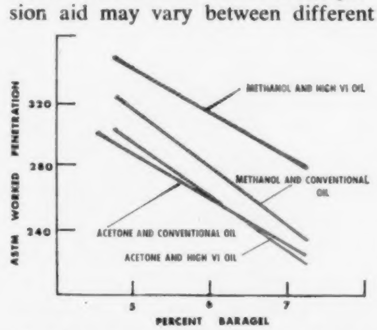
BARAGEL has proved to be efficient in greases compounded with all types of petroleum oils, including solvent refined, high VI oils. Tests were made with a base oil of 30.4° API gravity at 60° F and a viscosity of 356 SUS at 100° F.



BARAGEL was stirred into the oil, acetone added and stirred, and the mixture was milled. Greases having an ASTM worked penetration in the 315 range required about 4.5% BARAGEL, while greases in the 280 range required about 5.5% BARAGEL. Data Sheet A-1, available on request, gives full details of this test.

BARAGEL works efficiently with wide range of dispersing aids

As a grease gelling agent, BARAGEL works well in oils of low, medium or high viscosity, where the dispersion aid is either acteone or methanol. The influence of the dispersion aid may vary between different



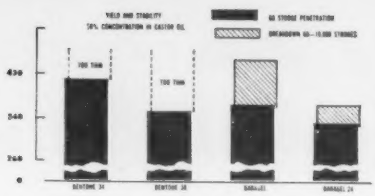
oils. The chart shown here illustrates the changes resulting from use of oils of varying viscosity.

It will be noted that the influence of acetone on yield at optimum concentration is essentially the same for both a conventionally refined oil and a highly refined, high VI oil. There is, however, a marked difference in the influence of methanol on yield at optimum concentration in the same two oils.

Complete details of a series of conclusions drawn from tests are available on BARAGEL Data Sheet A-8.

Greases made with castor oil

BARAGEL 24 has been proved by tests to be exceptionally efficient in thickening castor oil. Greases prepared with BARAGEL 24 are also much more stable to working in the ASTM grease worker.



Tests were made to compare results when thickening greases with BENTONE 34, BENTONE 38, BARAGEL and BARAGEL 24. The results are shown in the accompanying chart and details are available in Data Sheet A-5.

Worked penetrations of greases made with castor oil and 10% BARAGEL 24 were 325, with a penetration of 365 after working 10,000 strokes.

BARAGEL 24 improves efficiency in non-petroleum oils

Just as BARAGEL was the result of specialized research to make BENTONE 34 even more effective as a grease gelling agent, in the same manner BARAGEL 24 has been developed as an improvement over BARAGEL in thickening greases made with non-petroleum oils.

BARAGEL 24 works unusually well in compounding greases made from such non-petroleum oils as polyalkylene glycols, di-2-ethylhexyl sebacate, di-2-ethylhexyl adipate and castor oil. While BARAGEL 24 may not find widespread use in thickening most petroleum oils, it is possible that BARAGEL 24 may prove to be best for certain specific petroleum oils.

The improved efficiency of BARAGEL 24 in non-petroleum oils has been achieved primarily through the nature of the organic ammonium halide used. The inorganic portion of the product is refined sodium montmorillonite.

News About NLGI

MINUTES OF 1959 ANNUAL MEETING TECHNICAL COMMITTEE

The acting secretary of the Technical Committee, H. J. Liehe has prepared the following summary of the meeting held at New Orleans on October 28, 1959.

Reports of Subcommittees

Fundamental Research — L. C. Brunstrum, Chairman

The committee has been working primarily in two areas, namely flow and structure of lubricating greases. The present fellowship is concerned with flow. At the 1958 meeting, the Technical Committee had recommended to this subcommittee that consideration be given to establishing a second fellowship. The subcommittee will recommend to the Board of Directors that a Fellowship on Lubricating Grease Structure be established. This recommendation was approved unanimously by the Technical Committee.

As for program plans for 1960, the subcommittee proposes a session on either Viscoelastic Properties or High Temperature Grease Lubrication.

The report by the Fellow, Kak-Choong Kim, of the University of Utah was presented by Mr. Kim. This dealt with a study of the flow of lubricating greases using an autographic rotational viscometer. Data showing thixotropic loops at ascending and descending shear rates were presented. Details will be published in the NLGI SPOKESMAN.

In regard to the Research Fellowship, a motion was made and passed to continue the present fellowship.

The new chairman will be E. L. Armstrong of Socony Mobil Oil company.

Procurement of Technical Papers for Publication in the NLGI Spokesman— C. J. Boner, Chairman

The advantages of publishing articles in the NLGI SPOKESMAN were emphasized by Mr. Boner. A brief summary of the number, nature, and source of the articles published in the SPOKESMAN was given by the chairman.

Editorial Review — George Entwistle, Chairman

Mr. N. W. Faust summarized the activities of this subcommittee as follows:

33 papers referred to the committee for review.

31 papers were reviewed and two remain to be reviewed.

27 papers were accepted with minor revisions recommended for three of these.

4 papers were rejected.

Manual of Test Methods and Definitions of Terms Peculiar to the Lubricating Grease Industry—W. J. Ewbank, Chairman

Two sets of definitions have been approved by the Board and published in the NLGI SPOKESMAN. A third set has Board approval and the accompanying article for this set is being considered for publication by the Editorial Review Committee.

Short form or significance articles on the dropping point and worked penetration methods have been approved by ballot vote of the committee and will be presented to the Board for approval prior to publication.

A fourth list of tentative definitions was handed out at the meeting. Letter ballot of approval will be sent out in a few weeks.

Recommended Practices for Packing Automotive Front Wheel Bearings— P. V. Toffoli, Jr., Chairman

Nearly 165,000 pamphlets on the above subject have been sold.

Work for 1960 will be directed toward bringing the current pamphlet up-to-date, especially from the viewpoint of photographs and illustrations.

Delivery Characteristics of Dispensing Equipment for Lubricating Greases— Gus Kaufman, Chairman

This project has been on the books for more than ten years. One of the primary aims was to determine limits of temperature, consistency and viscosity as related to dispensing. Most of the work has been done on automotive chassis greases. Gun manufacturers have been very helpful and were responsible for including the volume-viscosity curve rather than only the limiting viscosity.

A tentative method was published in 1955. Revisions have been made since that time and the present method, as reviewed at the Tuesday afternoon Session B on dispensing, has been written up in readiness for publication. Briefly, the gun manufacturer determines the delivery characteristics as related to apparent viscosity and the grease manufac-

Continued on page 464

Continued from page 462

turer determines the apparent viscosity versus temperature of the grease. These data are combined to determine what the system will do. The subcommittee recommends the following:

1) Publication of the present method in the NLGI SPOKESMAN.

2) Submission of the method to ASTM for formalization and possible future issuance as an ASTM method.

3) Consider the work of the present group as completed. Form a new committee to consider future work, with special consideration for work at lower shear rates as related to dispensing in industrial systems.

Manufacturing Operations—J. J. Dickason, Chairman

This subcommittee was only authorized last year. The major task for 1959 was the planning and organization of Tuesday's successful symposium on Manufacturing Equipment and Procedures.

Plans are being made for future projects in non-proprietary areas.

Consistency Projects—Melville Ehrlich, Chairman

This group endeavors to cover the whole area involved within the term consistency. It will serve as a watch dog and handle comments relative to the NLGI classification. Currently, consideration is being given to expanding the classification to the softer greases. This group will also act as a clearing house for information from other organizations, such as ASTM and CRC.

Utility and limitations of the new ASTM cone for grease penetration were discussed. NLGI should refrain from establishing new grades until ASTM comes to a final decision on the new cone. The marketing aspects must also be considered prior to making any change in the NLGI classification system.

Gear Lubricants—R. K. Smith, Chairman

This is a new subcommittee formed in 1959. Twelve companies were represented at the first meeting which was held on Monday morning. Work is primarily at the planning stage, but as a result of the discussion at the first meeting, the group has made the following recommendations:

1. NLGI have made active liaison with groups such as ASLE, SAE, and AGMA. Appoint representatives of NLGI to work in closer conjunction with gear lubricant committees of these other organizations and keep us informed.
2. Present a symposium on industrial gear lubricants at the annual meeting in 1960.
3. Conduct a review of the fundamental research being done on gear lubricants. This may lead to some recommendations of areas in which NLGI might recommend fundamental research projects in the field of industrial gear lubricants.

Grease Incompatibility Study Group—M. J. Pohorilla, Chairman

Results of a questionnaire sent to the NLGI Technical Committee in June, were presented. The highlights of the response to the questionnaire were summarized as follows:

1. Forty-five (45) members replied out of a total of 150 questionnaires mailed. This was a response of 30%.
2. There was almost an equal division of opinion as to whether grease incompatibility is a field problem.
3. Grease incompatibility has been encountered mostly in wheel bearing service, with industrial applications cited to a lesser degree.
4. An overwhelming majority of those replying (88.9%) were in favor of NLGI conducting an educational program, with most respondents favoring a publication as the most desirable mechanism for achieving this end.

In the ensuing discussion there was some division of opinion among those present, as to the frequency and seriousness of grease incompatibility problems. Also, opinion was divided in regard to the desirability of NLGI working on a project of this type.

A motion was made and passed that the NLGI Technical Committee institute a program of education in the area of grease incompatibility and that a publication would be the best means of effecting that end.

Steering Committee

Because Mr. T. G. Roehner has resigned as chairman of the Technical Committee, the meeting was turned over to the new chairman, Mr. L. C. Brunstrum.

The membership, activities, and duties of the Steering Committee were summarized by the chairman.

The Steering Committee is composed of the chairmen of all the committees and meets the day before the meeting to determine policy, program, etc. for the committees. This group met on Sunday and recommended that a symposium on some phase of fundamental research on lubricating greases be held at one of the sessions in 1960.

Work of the committee on Delivery Characteristics of Dispensing Equipment for Lubricating Greases is considered finished. A motion was made and passed to set up a Study Committee to investigate the realm of central lubrications systems and to make a recommendation relative to work in this area.

Some discussion was devoted to a general committee on recommended practices. No specific decisions were reached, but Mr. Toffoli's committee will be on a standby basis to handle any new problems. This concluded the activities of the Steering Committee.

There being no new business, the meeting was adjourned. ■

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Presented by K. S. Cuddington at the NLGI 27th annual meeting in New Orleans, October, 1959

Retention of Liquids In Soap/Hydrocarbon Systems

By: A. J. Groszek and G. H. Bell
British Petroleum Co. Ltd.

Abstract

A description is given of the measurement of the vapour pressures of the liquid phase in soap-hydrocarbon systems. A novel method using the electric discharge detector is employed for these measurements. The results are used to construct desorption isotherms for the systems, from which information is obtained concerning the surface area of the solid phase and the proportion of liquid phase present in pores that are sufficiently small to depress the vapour pressure of the liquid.

It is considered that such information should permit an estimation of the ability of soaps to retain the liquid phase in greases at different temperatures and should give a measure of the mechanical stability of greases.

The results shown for lithium stearate and lithium hydroxy stearate systems, in the temperature range investigated (55 to 120°C), indicate that the liquid phase is bound more firmly in the latter systems at temperatures above 100°C. It is shown also that the straight chain paraffins are held much more strongly by both soaps than is a branched paraffin, and that the addition of glycerol to lithium hydroxy stearate greases causes a decrease in the surface area of the thickener.

Introduction

It is well known that greases consist of a more or less rigid network of solid particles with interstices filled with a liquid phase.

An essential property of greases is to offer a resistance to flow when subjected to small mechanical stresses. This property is dependent upon the ability of the particles of the thickener to form a structure, i.e., to adhere to each other and to form a rigid skeleton filled with oil. The oil is held in this network of particles by being sorbed, or adsorbed on their walls and by capillary forces.

Most of the oil in greases is held by capillary forces in the interstices between the fibres. The oil present in large interstices or pores can be removed from the grease structure by relatively low pressures[1]. However, as the interstices become smaller, higher pressures are required to expel the oil. When the cross-section of pores is of the order of a few hundred angstroms, the vapour pressure of the liquid present in such micro-pores decreases measurably[2]. At the same time the liquid is held in the pores very tenaciously and can be removed from them only by the application of very high mechanical pressures[3].

The vapour pressure of the oil that is adsorbed by a thickener may be depressed even more than that of the liquid present in the micro-pores.

Thus by determining the vapour pressure of the liquid held in greases, it should be possible to establish the proportion of liquid held in the large interstices, from which it can be removed relatively easily by mechanical pressure, the proportion of liquid held very strongly in the micro-pores, i.e., pores sufficiently small to decrease the vapour pressure of the liquid contained in them, and the proportion of the adsorbed liquid.

This paper describes a method for the continuous measurement of the evaporation losses of the liquids held in greases. Vapour pressures are calculated from these losses and the application of the method is illustrated by the examination of systems composed of pure lithium stearate and lithium hydroxy stearate dispersed in normal and iso-paraffins.

Apparatus and Procedure

1. *Construction of the Vapour Pressure Apparatus*

The apparatus for the measurement of the vapour pressures consists essentially of a simple electric discharge tube through which a stream of air is passed saturated with the vapour of the liquid phase present in a grease.

The voltage drop across the discharge is very sensi-

tive to changes in concentration of the hydrocarbon vapour in the stream of air. When the air stream is fully saturated with a hydrocarbon vapour at a given temperature, the change in voltage occurring across the electrodes can be related to the vapour pressure of the hydrocarbon at that temperature.

The construction of the apparatus is similar to that described by Pitkethly[1], with certain modifications to adapt it for the determinations of the vapour pressure of relatively high boiling hydrocarbons. The apparatus is shown in Figure 1 and the ancillary circuit in Figure 2.

The modified neon lamp (G) is joined to the rest of the apparatus by means of a soda-pyrex seal. Capillary tubing (D) is used to decrease the pressure inside the detectors to about 3 mm Hg. The vapour of the hydrocarbon is introduced into the lamp by drawing the air through a transpiration bottle (M) and allowing it to pass over a small, shallow stainless steel dish (A) containing the grease sample prior to its being introduced into the detector. Air is drawn through the bottle at the rate of 9 ml/min. This flow is sufficiently slow to obtain an almost complete saturation of the air with the organic vapour. The dishes are made from stainless steel with recesses of varying depths in which different amounts of greases are placed. The dishes are located centrally under the sintered plate (B) at the bottom of the transpiration bottle (M) by means of a metal ring which the dish fits loosely.

The current from the detector in contact with the hydrocarbon vapour (analytical detector) is compared

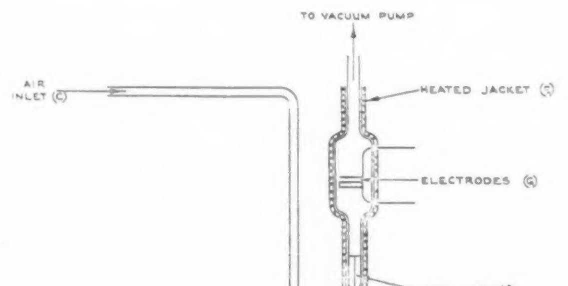

FIGURE 1—Construction of vapour pressure detector used.

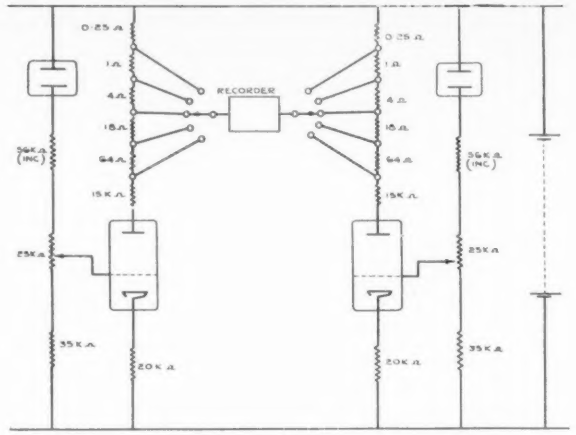

FIGURE 2—Bridge circuit used to match the impedance of the detector outputs to the impedance of the recorder.

with the current flowing through the identical detector (reference detector) through which the air stream without any hydrocarbon vapour is flowing, the air being drawn from the same source. This arrangement ensures that the changes in voltage registered by the apparatus are due only to the introduction of the hydrocarbon vapour into the analytical detector and not to impurities which might be present in the air.

Adsorption of the vapours on the walls of the detectors was minimized by enclosing them in heated jackets and raising the temperature of the walls to about 150°C.

It may be noted that detectors other than that described could be used for the estimation of evaporation losses, for example, most of the detectors used in gas chromatography.

2. *Circuit*

The circuit used to match the impedance of the detector outputs to the impedance of the recorder is essentially the same as that used by Pitkethly.[1] The circuit is shown in Figure 2 and consists of a double triode on to the grids of which the output from the detectors is fed. The input to the recorder is then fed from the anode circuits of the valves, the network of the resistors giving a number of voltage ranges. Balance between the two detector circuits is achieved by use of the potentiometers placed in the grid circuits of the valves.

3. *Procedure*

About 30 mg of a grease is weighed accurately into the stainless steel dish. A uniform surface of the grease sample is obtained by packing the recess in the dish with grease and removing the excess with a razor blade, the edges of the dish then being wiped dry. The dish is placed in the transpiration bottle which is then immersed in the thermostatic bath and con-

nected to the detector. The temperature of the bath is adjusted previously to a value at which it is desired to carry out the measurement of the vapour pressure.

Upon the evacuation of the detectors to 3 mm Hg, the air begins to flow through the transpiration bottle, becomes saturated with the vapour of the liquid present in the grease, and passes through the detector. The output from the detector is recorded continuously by a potentiometric recorder giving the voltage corresponding to the vapour pressure of the grease with a continually increasing proportion of the thickener.

The weight of the evaporated liquid is obtained from the weight of the metal dish, after the vapour pressure falls to zero, and the weight of the dish filled with grease. The area under the recorded curve is measured and related to the total weight of evaporated liquid. The amount of liquid evaporated in any given time is obtained by comparing the area under the curve corresponding to this time and the total area under the curve.

The vapour pressures can be calculated from the evaporation losses if the gas flowing over the grease is fully saturated with the vapour of the liquid. The losses are then proportional to the vapour pressure. Assuming that Dalton's law of partial pressures holds and that the vapour behaves ideally, we have:-

$$pV = \frac{W}{M} RT \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where p is the partial pressure of the vapour, V is the total volume of gas and vapour formed in the transpiration bottle, W is the weight of liquid vaporized, and M is the molecular weight of the vapour.

All the greases examined in the present work have been prepared by rapid cooling to room temperature of solutions of the soaps in the solvents used.

4. *Calibration*

The output from the detector was registered by the recorder for three straight-chain paraffins kept at different temperatures. The calibration was carried out by placing these substances in the stainless steel dish and passing air over them at different temperatures. The response of the recorder was plotted against the vapour pressure of the paraffins given in the literature[5]. The straight lines obtained in this way are shown in Figure 3.

Materials Used

1. Lithium stearate - this material was made from metallic lithium and stearic acid (purity 99.5 per cent, mp 68.5°C). The purity of the lithium is stated by the manufacturers to be 98 per cent.

2. Lithium hydroxy stearate - commercial material supplied by Hardman and Holden Limited.

3. Dodecane Purity 99.5 per cent

4. Hexadecane Purity 97.9 per cent

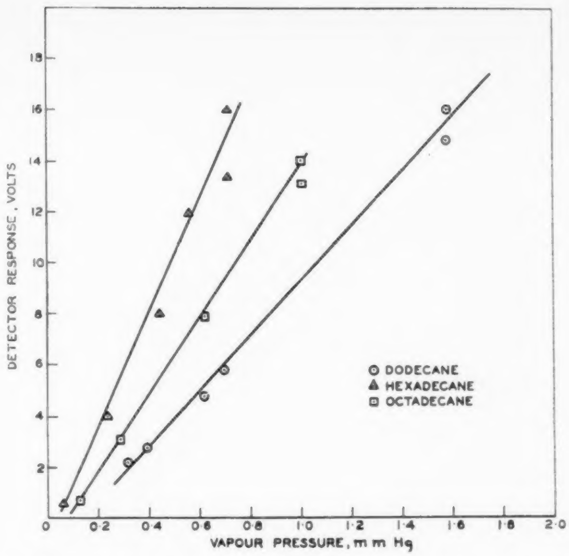

FIGURE 3—Calibration curves for the vapour pressure apparatus.

5. Octadecane Purity 99.9 per cent

6. 3:3, 6:6, 9:9, 12:12 octamethyl tetradecane, purity not known.

Results and Discussion

To illustrate the application of the method, results are shown for the systems composed of lithium stearate and lithium hydroxy stearate dispersed in dodecane, hexadecane, octadecane and 3:3, 6:6, 9:9, 12:12 octamethyl tetradecane, the evaporation losses being determined at 55°, 100°, 120° and 120° respectively.

The curves printed by the recorder are shown in Figures 4 and 5 for lithium stearate and lithium hydroxy stearate greases respectively. In each case the voltage recorded corresponds to a given vapour pressure and as the vapour of the liquid phase in the greases is removed by the air stream, the solid content increases and a point is reached eventually at which a gradual decrease of the voltage takes place. The evaporation losses decrease initially at an increasing rate until a point is reached at which they fall at a constant rate. Subsequently the rate of decrease of the losses slows down until it reaches a very small value.

In order to establish a connection between the vapour pressure curves and the retention of liquid in greases it is assumed that greases consist of a maze of thickener particles with the interstices filled by oil. Such a representation of greases is supported by electron micrographs of grease aerogels, i.e., greases from which oil is removed and replaced by air in such a way as to preserve the structure of the thickener, which show that they consist of continuous irregular networks of soap fibres of varying diameter[6]. A schematic drawing based on a photomicrograph of a lithium

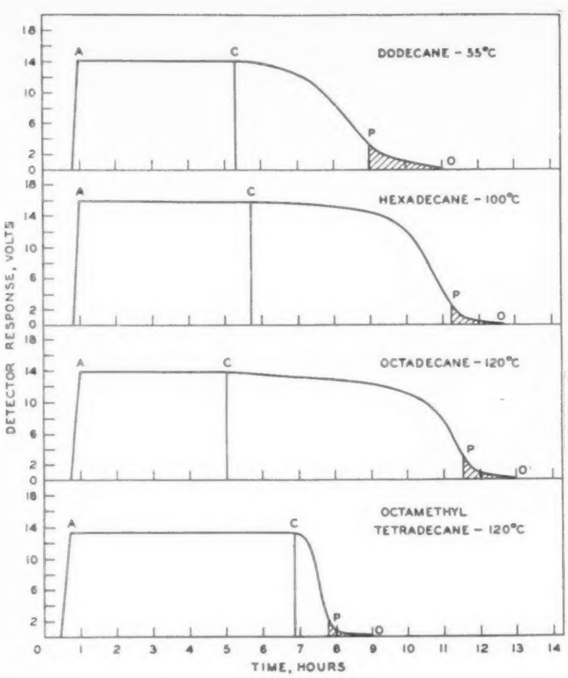

FIGURE 4—Evaporation rates of lithium stearate systems.

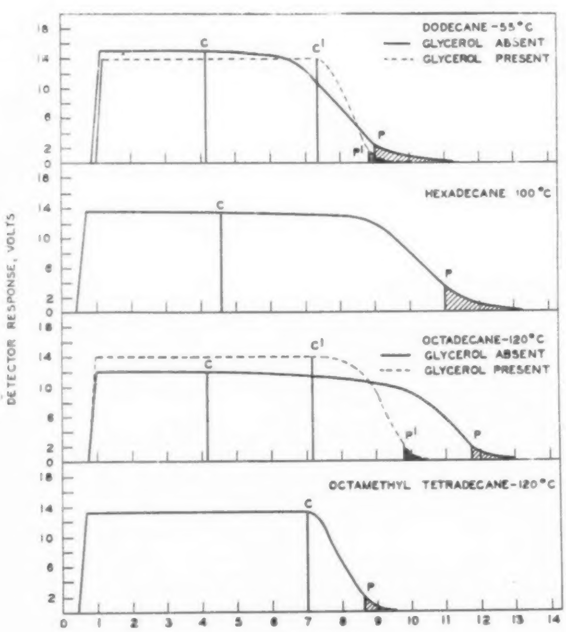

FIGURE 5—Evaporation rates of lithium hydroxy stearate systems.

stearate aerogel is shown in Figure 6.

The appearance of an aerogel is that of a chalky, rather brittle, opaque, white, porous solid[7]. The rigidity of the structure is caused by the adhesion between the fibres at their points of contact[8].

The surface area of sodium and lithium stearate aerogels, as determined by nitrogen adsorption, is 80-100 sq m per g. This estimate has been confirmed

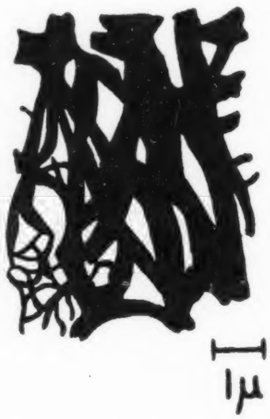

FIGURE 6—A schematic drawing based on an electron photo-micrograph of a lithium stearate aerogel.

by direct calculation from electron micrographs, which show that the fibres in the aerogels are solid, smooth and without sub-microscopic pores, their thickness being an average about 600 Å[6].

As can be seen in Figure 6 the size of pores in the aerogel skeleton varies approximately from less than 1,000 Å to 10,000Å. The pores are very irregular in shape and unevenly distributed.

Let us consider a grease, similar to that represented in Figure 6, from which the liquid phase is continually removed by evaporation. It may be expected that the vapour pressure of the liquid evaporating from the large pores between the fibres remains very similar to that of the liquid in bulk. Subsequently, when the liquid begins to evaporate from the spaces or pores possessing a diameter of the order of a few hundred Angstroms, the vapour pressure decreases measurably. This decrease is due to capillary forces, and, assuming that the Kelvin equation is applicable, it may be related to the size of the spaces from which the liquid evaporates[2]. The Kelvin equation is as follows:—

$$\log e \frac{Po}{P} = \frac{2\gamma M}{\rho RTr} \qquad 2$$

where Po and P are the vapour pressures of the liquid in bulk and the pores respectively, γ, ρ, M and T are the surface tension, density, molecular weight and temperature of the liquid respectively, and r is a measure of the pore size.

Finally, the last stage of evaporation is characterised by vapour pressures being three or four times

lower than that of the liquid in bulk, such a lowering of vapour pressure being due to adsorption of the liquid on the fibres.

The three stages in the removal of liquid from greases are often encountered for many semi-solid systems other than greases. Thus, for systems composed of silica and water, starch and water, clay and water, etc., the evaporation of water proceeds at different rates depending on the water content of these systems[9].

Similarly, Kazanski has found that the evaporation of water from carbon-water and silica-water systems can be divided according to the type of forces retaining the liquid in these systems [10]. The stages are as follows:—

1. Evaporation of liquid from pores with diameter greater than 1000 Å.
2. Evaporation of liquid from pores with diameter less than 1000 Å.
3. Evaporation of adsorbed liquid.

The adsorbed liquid may be confused in certain instances with the liquid contained in micropores since both act to reduce the vapour pressure. The same difficulties are also encountered in the field of solid adsorbents[11].

In addition to the liquid which is adsorbed, there is evidence for the occurrence of sorbed liquid which enters the crystals of the thickener particles, the sorption being accompanied by swelling.

The evidence for the sorption of liquid hydrocarbons by lithium stearate and other soaps is furnished by the considerable heat effects produced when coarsely powdered soaps come into contact with n-heptane at room temperature[12]. The magnitude of the heats evolved is such that they could not have been caused only by adsorption on the available free surface which was below 1 sq m per g. Nor could the heat have been caused by any solution of the soap taking place, because at room temperature the soaps are practically insoluble in n-heptane.

The vapour pressure of the sorbed liquid may be expected to decrease, at least to the same degree as that of the adsorbed liquid, the decreases probably being greater in both cases than for the liquid present in the micro-pores.

The graphs in Figures 4 and 5 can be interpreted with the aid of Figure 7 which gives a diagrammatic representation of two thickener fibres with the enclosed liquid, making a contact at O. This diagram may be considered as a magnification of one of the interstices visible in the photo-micrograph represented in Figure 6.

As can be seen in Figures 4 and 5 the vapour pressure begins to fall measurably at C. Referring to Figure 7, this point probably corresponds to the stage at which

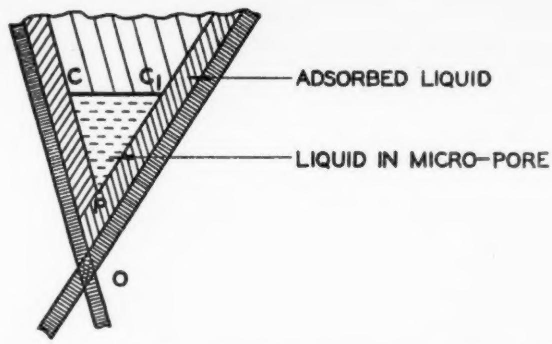

FIGURE 7—A schematic drawing of two thickener fibres.

the liquid between the fibres reaches the level C C_1, the distance between the fibres at this level lying between 500 and 1000 Å. The vapour pressure then decreases slowly until all the liquid between the fibres is evaporated, whereupon point P is reached at which all the liquid present in the grease structure is that adsorbed on the walls of the fibres or sorbed by the soap. At that point the pressure of the adsorbed or sorbed liquid should differ considerably from that of the liquid held in the capillaries.

If it is assumed that the third falling period corresponds to the evaporation of the unimolecular adsorbed films it would be possible to estimate the amount of liquid in a grease which forms such a film. From the knowledge of the cross-section of the molecules in the film the surface area of the thickener in a grease can be evaluated. Unfortunately, it is not possible at present to decide what is the configuration of molecules in the adsorbed film and therefore the cross-section of the molecules cannot be estimated, which precludes the calculation of the surface areas. In addition, the presence of the sorbed liquid would further complicate such calculations, unless it is assumed that the sorbed liquid is equivalent to the liquid adsorbed on a given amount of surface area. However, in spite of the difficulties associated with the calculations of the absolute surface areas, the relative values could be obtained by comparing the total amounts of adsorbed liquid for greases composed of different thickeners and similar liquids.

It was found in the present work that the relative pressures at which the evaporation of the strongly adsorbed liquid begins lie in the region of 0.10 to 0.25. Harkins states that the evaporation of the unimolecular films of n-butane from non-porous surfaces usually takes place at the relative pressures between 0.15 and 0.25[11]. This lends support for the assumption that the amounts of hydrocarbons evaporated from the greases in the last stage measure the surface areas of the soaps.

For the systems examined in this work comparisons are made between the amounts of liquid lost during the last stage of evaporation, i.e., between P and O as

shown in Figures 4 and 5. This liquid is assumed to be strongly adsorbed on the surface of the soap fibres, its relative amounts in different greases measuring the surface areas of the thickeners.

The proportions of the strongly adsorbed liquid and the total liquid with a decreased vapour pressure in the lithium stearate and lithium hydroxy stearate greases are given in Tables 1 and 2 respectively.

TABLE 1

Strongly Adsorbed Liquids in Soap-Hydrocarbon Systems

Liquid	*Strongly Adsorbed Liquid % w/w*			
Soap	*Dodecane 55°C*	*Hexadecane 100°C*	*Octadecane 120°C*	*Octamethyl Tetradecane 120°C*
Lithium Stearate	3.4	2.1	0.6	0.5
Lithium Hydroxy Stearate	2.8	2.7	1.1	0.6
Lithium Hydroxy Stearate+Glycerol	1.4	—	0.7	—

TABLE 2

Proportions of Liquids with Decreased Vapour Pressure in Soap-Hydrocarbon Systems

Liquid	*Proportion of Liquid with Decreased Vapour Pressure % w/w*			
Soap	*Dodecane 55°C*	*Hexadecane 100°C*	*Octadecane 120°C*	*Octamethyl Tetradecane 120°C*
Lithium Stearate	48.5	55.0	25.0	7.5
Lithium Hydroxy Stearate	43.5	54.0	59.0	12.0
Lithium Hydroxy Stearate+Glycerol	18.5	—	20.0	—

It can be seen that, for lithium stearate, dodecane is the liquid adsorbed to the greatest extent. As the temperature increases the proportions of adsorbed liquids decrease. At 120°C the amount of strongly adsorbed octadecane is less than one third of that for a similar system at 100°C containing hexadecane.

Considering the amounts of the liquids with a decreased vapour pressure, it can be seen in Table 2 that the increase of temperature has little effect between 55° and 100°C, but has a marked effect between 100° and 120°C, the proportion of octadecane that has a decreased vapour pressure decreasing to 25 per cent. These effects are not likely to be caused by slight differences in the nature of the hydrocarbons, which are all straight-chain paraffins, the chain length differing at the most by six methylene groups. It is probable, however, that the decrease is associated with a crystalline transition which is known to take place in lithium stearate systems at about 100°C[13].

For lithium hydroxy stearate systems the amounts of liquids with a decreased vapour pressure do not decrease with temperature up to 120°C as is the case for the lithium stearate systems. On the other hand, there is a decrease in the amounts of the strongly adsorbed liquids, but not to such an extent as for the lithium stearate systems.

It can be concluded therefore that, for the systems studied, the increase of temperature between 55° and 120°C has an effect of decreasing the surface areas of the thickener, which is especially noticeable for the lithium stearate system between 100° and 120°C. At the same time, the total amount of liquid with a decreased vapour pressure, appears to increase with temperature for the lithium hydroxy stearate systems and decrease markedly for the lithium stearate systems. This suggests that the latter systems do not maintain their micro-structure with increasing temperature to the same extent as the lithium hydroxy stearate systems.

A very striking result is obtained for the systems containing octamethyl tetradecane, an example of a highly branched hydrocarbon. The amounts of this liquid that are strongly adsorbed, and especially those with decreased vapour pressure, are very much below the corresponding amounts of octadecane. This suggests that the chemical structure of the hydrocarbons forming the liquid phase in greases could greatly affect their properties.

Another striking result is obtained when glycerol is added to lithium hydroxy stearate systems. As can be seen in Tables 1 and 2, the proportions of strongly adsorbed liquids and the proportions of liquids held in micro-pores are relatively low for the systems containing glycerol. This suggests that the addition of glycerol decreases the surface area of the soap fibres and the number of micro-pores in the system. It must be remembered, however, that this result applies only to the systems prepared by the precipitation of the soap dissolved in the light hydrocarbons. It is possible that different results would be obtained if the greases were prepared by another method, for example, neutralisation of 12-hydroxy stearic acid by lithium hydroxide followed by heating to 170°C and slow cooling to room temperature.

The results shown in Figures 4 and 5 and Tables 1 and 2 are expressed in the form of desorption isotherms in Figure 8. By comparing the isotherms with those obtained by many workers for porous solids, it may be concluded that the systems studied in the present work are composed from solids with a high surface area and very high capacity to bind the liquid hydrocarbons physically.

In general, the region of liquid with decreased vapour pressure, as indicated in Figures 4 and 5, corresponds to

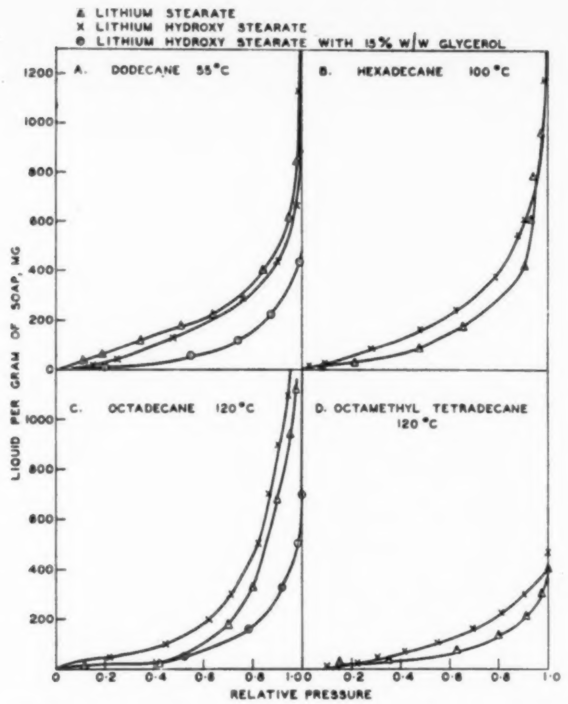

FIGURE 8—Desorption isotherms for soap-liquid systems.

the adsorbate at the relative pressures of 0.20-0.99, and the strongly adsorbed liquid is that adsorbed at the relative pressures below 0.20. In agreement with the assumptions indicated above, it is considered that the amount of the latter liquid is a measure of the surface area of the soap and the amount of liquid adsorbed at relative pressures above 0.20 is a measure of the micro-porosity of the thickener. Furthermore, the liquid adsorbed at the relative pressures of 0.9 to 1.0 is assumed to be held in pores, or interstices, of a greater size than the liquid held at the pressures of, say, 0.5 to 0.6.

By comparing the isotherms for lithium hydroxy stearate systems containing straight-chain paraffins, it can be seen that at high relative pressures more octadecane than either hexadecane or dodecane is held in relatively large micro-pores. Thus, for example, between the pressures of 0.8 and 0.9, 400 mg of octadecane per g of soap is held, which can be compared with 200 mg. of hexadecane and 130 mg. of dodecane held at the same pressures. The effect shown is probably due entirely to the different temperatures for which the isotherms are drawn and, therefore, it would appear that the proportion of the relatively large micro-pores in lithium hydroxy stearate systems increases with temperature over the range investigated (55°-120°C).

The amounts of different hydrocarbons held at low relative pressures do not differ greatly. For example, between the pressures of 0.4 and 0.5, 40 mg of octadecane per g of soap is held, compared with 50 mg for hexadecane and 40 mg for dodecane systems. It may be inferred, therefore, that the amount of liquid held in relatively small micro-pores does not change with temperature to any appreciable extent in lithium hydroxy stearate systems.

As could be inferred from Figures 4 and 5, the systems containing glycerol exhibit a lower micro-porosity than the systems without glycerol over the whole range of relative pressures. The same is true for the systems containing octamethyl tetradecane. The lithium stearate systems at 100°C and 120°C give isotherms lying below those of lithium hydroxy stearate systems, which may be interpreted as a sign of a higher micro-porosity of the latter systems.

In order to establish whether there is any connection between the surface areas and micro-porosity, as indicated by the desorption isotherms, for the various systems investigated and the "bleeding" of the systems, as determined by a conventional test at 100°C[14], a series of tests was carried out on lithium stearate and lithium hydroxy stearate-hexadecane systems, without and with the addition of glycerol. The results of these tests are given in Table 3 below:—

TABLE 3

Bleeding of Greases at 100° C

Grease	*Liquid Separation % by wt*
10% Lithium Stearate	11.6
10% Lithium Hydroxy Stearate	1.5
20% Lithium Stearate	0.7
20% Lithium Hydroxy Stearate	0.5
10% Lithium Hydroxy Stearate + Glycerol	17.0

It can be seen that the amounts of the liquid separated from the systems containing glycerol are greater than those separating from the systems not containing glycerol. This corresponds to the decreases in the surface areas of the soap in the octadecane system on addition of glycerol, as can be seen in Table 1. Similarly, the separation of liquid from lithium hydroxy stearate is less marked than that for the lithium stearate systems, agreeing with the estimated order of the surface areas of the soaps at temperatures of 100° and 120°C.

Conclusions

Measurements of the evaporation losses of the liquid phase in soap-hydrocarbon systems can be carried out by a novel method using the electric discharge detectors for the determination of the vapour pressure of the liquid phase. The results can be used to construct desorption isotherms for the systems, from which information can be obtained concerning the surface area of the solid phase and the average size of pores in the grease structure. It is considered that such information

should permit an estimation of the ability of soaps to retain the liquid phase in greases at different temperatures and to obtain a measure of the mechanical stability of greases. The latter property should correlate with parameters related to the surface area of the thickener[15].

The results shown for lithium stearate and lithium hydroxy stearate systems, in the temperature range investigated (55° to 120°C) indicate that the liquid phase is bound more firmly in the latter systems. Such systems should consequently exhibit better bleeding characteristics than the lithium stearate systems. This is in fact confirmed by the results obtained by bleeding tests for greases composed of the soaps and hexadecane.

It is shown also that the straight-chain paraffins are bound by both soaps much more strongly than is a branched paraffin, and that the addition of glycerol to lithium hydroxy stearate greases causes a decrease in the surface area of the thickener.

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Presented at the IOCA 12th annual meeting, Chicago, September, 1959

The "New Look" in Automotive Axle Gear Lubricants

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D. W. Dinsmore
Monsanto Chemical Co.

ALTHOUGH THERE HAS been considerable verbiage on the subject of gear lubricants in the last several years, the technology is changing rapidly and quite frequently new information is available. The objective of this presentation will be to acquaint you with recent developments in this important area of lubrication.

The significance of these new developments and the benefits to be derived from their use will be best understood if the historical perspective of gear lubricants is fresh in our minds.

Approximately thirty years ago, the first automotive vehicle utilizing the hypoid gear was manufactured and lubrication problems were immediately encountered. The first successful passenger car hypoid gear lubricants were of the lead-soap-active sulfur type; however, corrosive wear resulting from the extreme activity rendered them unsatisfactory for use in heavy duty truck and bus type service.

Within ten years, the hypoid axle was universally adopted by the automotive industry. The need for lubricants having satisfactory performance over a wide range of operating conditions resulted in the development of sulfur-chlorine type lubricants which were later defined by Federal Specification VV-L-761. These lubricants served to protect the gear against scoring and scuffing type failures. Chemically, the sulfur and chlorine functioned by selectively reacting with the gear surface to form metal sulfides and chlorides which act as solid lubricants.

Preceding and during World War II, inadequacies in these VV-L-761 lubricants, particularly in the area

TABLE 1

Physical Requirement
MIL-L-002105A Formulations

Property	*Grade 80*	*Grade 90*	*Grade 140*
Viscosity, @ 210°F.			
Kinematic, Centistokes	8.8-11.6	16.8-19.2	25.7-34.3
(Saybolt universal seconds)	(55-65)	(85-95)	(120-160)
Viscosity, @ 0°F.			
Kinematic Centistokes, maximum	10,850	65,200	....
(Saybolt universal seconds, maximum)	(49,900)	(300,000)	....
Viscosity Index, minimum	....	....	75
Channel Characteristics, °F., minimum	-30	0	20
Flash Point, °F., minimum	325	350	375
Flash Point, base stock blend, °F., minimum	350	375	425
Viscosity, @ 210°F., base stock blend, Centistokes, minimum	7.2	15.6	22.8

of high torque-low speed performance, were in evidence. Recognition of these performance requirements resulted in the development of multi-functional lubricants which were defined by Ordnance Specification 2-105B, issued in 1946. These lubricants with minor modifications were subsequently identified as MIL-L-2105, and products of this type have been available and have performed admirably for a number of years.

So much for the early historical aspects of gear lubricants. Now let's take a look at what has been going on in the last decade.

Early in 1952, the United States Ordnance Department recognized the deficiency of existing gear lubricants with regard to high torque-low speed performance in Ordnance vehicles. In view of the field performance difficulties, full-scale fleet tests were initiated to define the problems and to establish a basis for the preparation of new specifications.

FIGURE 1.

Concurrent with this development, the automotive manufacturers were experiencing axle difficulties as a result of the ever increasing demands being placed upon gear lubricants. Mr. C. M. Heinen stressed this at the ASLE Meeting in 1957 by showing the rapidly increasing trends in engine horsepower and gross weights of passenger cars and trucks.[1] Incorporated with these increases was the trend toward smaller axles and increased offset of the pinion gear to give lower silhouettes. The combination of these factors caused severe scoring difficulties in passenger cars. Higher average road speeds and gross load capacities imposed additional severity for truck axles. As a result, automobile and truck manufacturers were vitally interested in the development of improved gear lubricants.

Using the existing measures of quality; i.e., the L-19 and L-20 tests, MIL-L-2105 oils were already nearly perfect. Therefore, new techniques for evaluating lubricant quality were needed. Results of the 1953-54 Ordnance field tests established the necessary severity

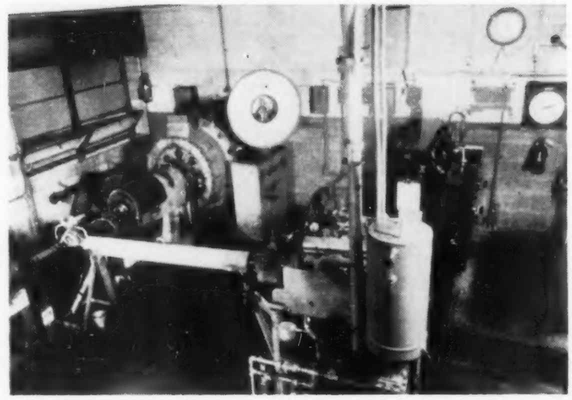


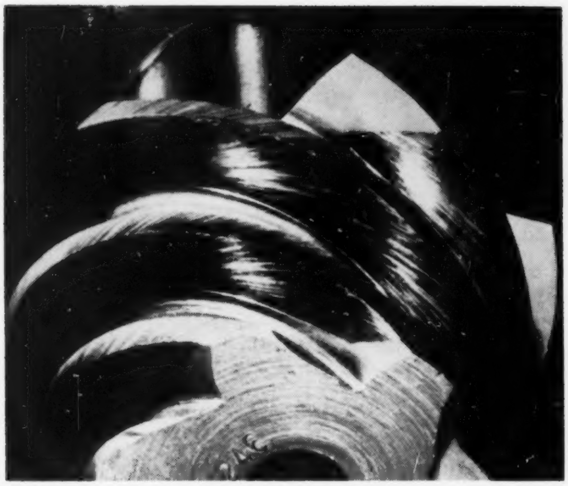
FIGURE 2.

level for the high torque-low speed performance in Ordnance vehicles. Three years of work by industry and Ordnance through the CRC committees, went into the development of the resulting CRC L-37 test.

The development of a test to evaluate the high speed-low torque anti-scoring properties was complicated by the lack of means for describing the necessary performance level. The Reference Oil system, suggested by T. P. Sands of Monsanto Chemical company[2] gave the automotive industry a tool for such a definition, and industry spent thousands of dollars over a 1½-year period to establish these requirements for a satisfactory passenger car lubricant. After approximately three years of work by industry through the CRC, the L-42 test was established.

Obviously, any new lubricants or specifications to be developed must be of a quality consistent with the latest requirements of both the military and the automotive industry. In May, 1957, the multi-purpose gear lubricant designation GL-4 was established by API and in January, 1959, Ordnance specification MIL-L-002105A was issued to describe lubricants of this quality. To acquaint you with all the performance requirements of the MIL-L-002105A type lubricants,

FIGURE 3.



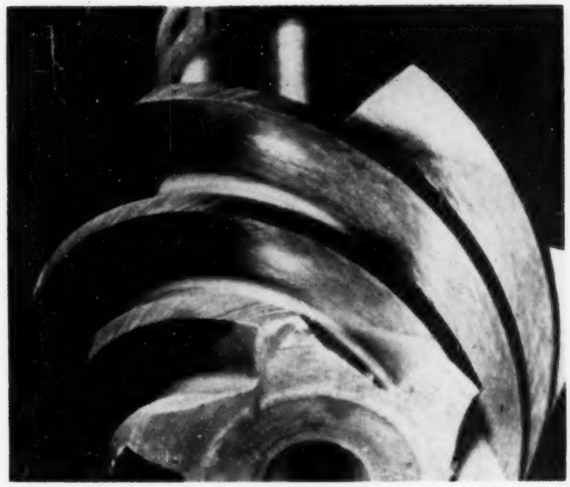


FIGURE 4—Results of the CRC L-37 test show typical MIL-L-2105 (left) versus MIL-L-002105A lubricants (right).

brief descriptions of the test techniques with comparative examples of the specimens are shown.

The physical properties of the SAE-80, 90 and 140 grade formulations are shown in Table 1. Please note that SAE-75 grade lubricants have not been included in the new specification. Also, the viscosity ranges of the SAE-80 and 90 grades have been revised upward to help compensate for the higher operating temperatures experienced in the field. Other changes include a maximum measured viscosity at 0°F. for the SAE-80 grade and revision of flash points on all grades.

The two full-scale CRC tests previously mentioned are included in the MIL-L-002105A specification and the equipment required for these evaluations is shown in Figures 1, 2 and 3. Currently, only four laboratories in the United States have this equipment available.

The first of these full-scale tests, the CRC L-37, measures the anti-wear and load carrying characteristics of the lubricant under conditions of high torque-low speed. The details of the test development were given to this group in 1957 by Mr. R. K. Williams, et al, of the Lubrizol corporation.[3] For information comparative results of typical MIL-L-2105 versus MIL-L-002105A lubricants are shown in Figure 4.

The CRC L-42 test is the second full-scale technique and measures resistance to scoring under conditions of high speed and shock loading. The test involves high speed accelerations and decelerations of a passenger car axle providing shock loading on both drive and coast sides of the gear teeth. Figures 5 and 6 show the results obtained with a MIL-L-2105 and MIL-L-002105A lubricant.

The Moisture Corrosion Test, adopted for the specification, was developed by Armour Research Foundation under contract with the Ordnance Department. The test oil containing 2 per cent water is motored in a Spicer axle at 2500 RPM for four hours at 180°F. After storage at 125°F. and 100 per cent relative humidity for 18 hours or seven days, whichever is required, the unit is rated for rusting. The sandblasted cover plate is the primary specimen. Figure 6 illustrates the degree of protection afforded by some MIL-L-2105 oils versus that for MIL-L-002105A lu-

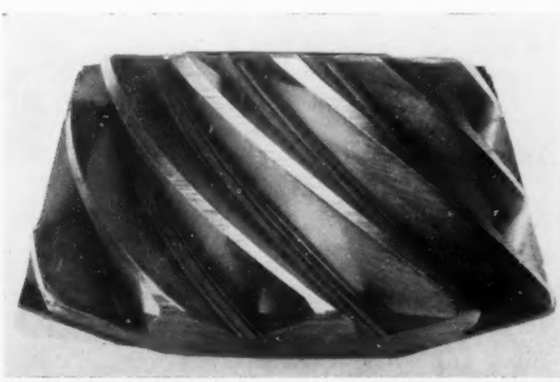


FIGURE 5—Results obtained in the CRC L-42 test with a MIL-L-2105 lubricant (left) and a MIL-L-002105A lubricant (right).

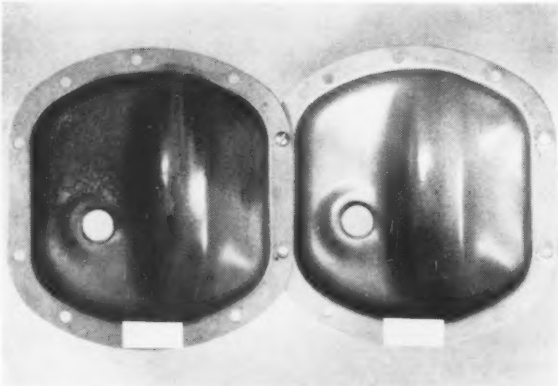


FIGURE 6—Results of the Moisture Corrosion Test.

bricants.

Field testing of gear lubricants has shown that some formulations are lacking in thermal stability under prolonged heavy-duty service. For this reason, a test to evaluate these characteristics was included in the new specification. There are many laboratory methods available for measuring such properties, and a technique, known as the Thermal Oxidation Stability Test, developed by the Ordnance Laboratory at Southwest Research Institute is used. In this test the lubricant is exposed to severe oxidizing conditions and thermal stresses in a specially designed gear case containing two spur gears and a test bearing. The steel gears, under light loading, circulate the oil over a copper catalyst while the bulk oil temperature is maintained at 325°F. Air is bubbled through the oil at the rate of 1.11 liters per hour. Lubricant rating is determined by examination of the viscosity increase and pentane and benzene insolubles of the used oil after 50 hours of operation. Good correlation is obtained with field tests. Table 2 compares the performance characteristics of several base stocks and additive formulations.

Solubility and compatibility requirements have remained unchanged from the MIL-L-2105 requirements. Allowable foaming characteristics, measured by the ASTM procedure, have been made more severe. The amount of foaming is measured immediately following the bubbling period rather than at the end of a settling period and has been drastically reduced.

To obtain a better perspective of the specification, Table 3 itemizes the approval tests with the acceptable performance limits. Obviously, only superior lubricants will meet these requirements.

A great forward stride was taken during the last half of the decade with development of this specification. However, another development took place which imposed still additional requirements on gear oils. This was the adoption of limited-slip differentials by several manufacturers on 1958 models.

The additional lubricity necessary for "chatter" elimination in the special differentials can easily upset the delicate additive balance of the formulation. For this reason, selection of the lubricity agent must be done with great care.

To evaluate additives for this type service, Monsanto Chemical company developed a dynamometer screening test which is both rapid and economical. Using a commercial limited-slip differential on the laboratory test stand unequal axle loads of 475 and 2050 pound-inches of torque are applied respectively to the left and right dynamometers while rotating at 100 RPM. After bringing the lubricant temperature to 150°F., the throttle is closed. When sufficient differential action occurs, the throttle is repeatedly snapped open and closed to simulate action of the differential in a turn. Closing the throttle is initiated at a speed of 100 RPM on the faster dynamometer. If no "chatter" occurs, the dynamometer loading of 2050 pound-inches is successively increased to 5200, 8350 and 11,-500 pound-inches torque. The dynamometer loads are

TABLE 2

Thermal Oxidation Stability Performance
50-Hour Results
Comparison of Base Stock and Additive Combinations

Base Stock Type	*California Coastal*	*Conventional Mid-Cont.*	*Solvent Mid-Cont.*	*Solvent Mid-Cont.*
Additive Tyle MIL-L	–002105A	–002105A	–002105A	–2105*
Viscosity Increase, %	96	41	18	1220
Pentane Insolubles, %	1.8	2.5	1.2	3.4
Benzene Insolubles, %	1.0	1.0	1.0	1.0
Neutralization No.	3.6	3.75	2.6	19.7

* The Mil-L-2105 additive used for this comparison is nearly obsolete, and was used to show the performance of an unstable additive in a good quality base stock. Similar results would be obtained with a more stable additive and a low quality stock. Therefore both additive and base stock play an important role in the thermal stability of the final formulation.

TABLE 3
Performance Requirements
for
MIL-L-002105A Qualification

Test	*Fed. Std. 791 Method No.*	*No. of Tests Required*	*Acceptable Limits*
CRC L-42	6507-T	2-Untreated gears	<5% scoring at tooth tip
CRC L-37	6506-T	1-Untreated gear 1-Lubricated gear	No disturbance No disturbance
Moisture Corrosion	5326-T	1-1 day test or 1-7 day test	No corrosion <5% corrosion above oil level
Thermal Oxidation Stability	2504-T	1-50 hour	Vis. Inc. at 210°F. 100% Maximum Pentane Insolubles 3% Maximum Benzene Insolubles 2% Maximum
Foaming	3211	Seq. 1 75°F. Seq. 2 200°F. Seq. 3 75°F. after Seq. 2	300 ml Maximum 50 ml Maximum 300 ml Maximum
Storage Solubility	3455	1-30 day ambient storage	Residue 0.25% (w) of non-petroleum material
Storage Compatibility	3455	1-30 day ambient storage when mixed with 50% of each of four selected oils previously qualified	Residue 0.5% (w) of non-petroleum material

then reversed to give left hand turn conditions and the procedure repeated.

While less than 5 per cent of the automobile production contains these special differentials, the oil industry accepted the challenge, and a vast majority of gear lubricants sold at filling stations and to fleet accounts satisfies the limited-slip differential requirements in addition to meeting MIL-L-002105A requirements.

These comments should by no means be interpreted to indicate that the ultimate has been achieved in gear lubricants. As an example, improved performance in gear boxes and transmissions would broaden the application of these lubricants and ultimately lead to a truly multi-purpose product. Also, the new vehicles utilizing trans-axle units appear to have performance requirements which are not satisfied by currently available products. These and other areas deserving of research effort are being actively studied in our laboratory.

As a result of the establishment of the MIL-L-002105A (Ord) specification and the issuance of the API designation GL-4 for gear lubricants, recognition has now been gained for the latest development in gear lubricant technology. Although the MIL-L-002105A specification was issued in January, 1959, lubricants of this type have been commercially available for three years and as a result, valuable "field service" experience has been obtained. Today, practically every major oil company markets such products and they are available on a nation-wide scale. In addition, a majority of the independent compounders and distributors have made these products available to the vehicle owner.

With this development, it is now possible for the oil company to compound one lubricant having completely adequate performance in all automotive axles. This multi-functionality increases the oil compounders' potential for participation in the automotive lubricant requirements while assuring the supplier and vehicle owner of satisfactory performance. Additionally, the oil compounder has products available which can be used in lieu of factory part number materials which are specified by the manufacturer for limited-slip type axles.

At this time, it seems most appropriate to consider the axle manufacturer's attitude toward these lubricants. In a recent survey of the major manufacturers of passenger cars, with the exception of one company,

TABLE 4

Drain and Refill Recommendations
1959 Models

Cars		
Buick	No drain plug	No drain recommended
Cadillac	No drain plug	No drain recommended
Chevrolet	Yes	*10,000
Chrysler	Yes	20,000
DeSoto	Yes	20,000
Dodge	Yes	20,000
Edsel	Yes	No drain recommended
Ford	Yes	No drain recommended
Lincoln	No drain plug	No drain recommended
Mercury	Yes	No drain recommended
Oldsmobile	No drain plug	No drain recommended
Plymouth	Yes	20,000
Pontiac	No drain plug	No drain recommended
Rambler	No drain plug	No drain recommended
Studebaker	Yes	10,000
Trucks		
Chevrolet	Some models only	*15,000
Dodge	Yes	20,000
Ford	Yes	10,000
G. M.	Some models only	10,000
International	Yes	10,000
Studebaker	Yes	10,000
Willys	Yes	10,000

*Drain factory-fill at 1,000

all sanction the use of MIL-L-002105A lubricants and three refer to or specify these lubricants in their 1960 owners manuals and handbooks. With regard to the heavy duty truck type axle equipment, three manufacturers either specify or sanction the use of the new lubricants. Only one manufacturer recommends against their use and it is our understanding that current test work may reverse this recommendation.

As with any development that is new, the complete acceptance by the automotive industry and general recognition of the advantages afforded by the new gear lubricants has required considerable time.

During the early part of the last decade, some automotive manufacturers virtually "sealed-in" the factory-fill lubricant by removing the drain plug from the differential. They felt this defensive action was necessary since existing lubricants marketed at the filling station level demonstrated inadequate anti-scoring properties. This lack of drain plugs and make-up and refill recommendations by the automotive industry is the major stumbling block preventing the broad application of these products in automotive equipment and particularly in passenger cars. Table 4 indicates the current recommendations of the major automotive manufacturers. We call your attention to the general lack of uniformity with regard to drain and refill recommendations, and particularly the lack of drain plugs in many models. These very significant facts are a major problem and deterrent to new gear lubricant business for the lubricant compounder and retail service station.

In no way other than continued marketing of top quality products can the confidence of the automotive industry be regained, thus effecting reinstatement of the drain and refill practices so highly desirable. We sincerely believe the oil industry is doing an excellent job of regaining this confidence by widely marketing gear lubricants with the "new look." ■

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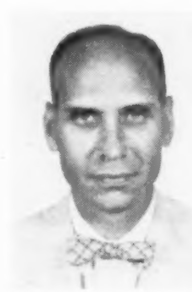

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More Sales — For You and Your Industry

By: J. Y. McCollister
McCollister Grease & Oil Corp.

Presented at the NLGI 27th annual meeting in New Orleans, October, 1959

MANUFACTURERS OF LUBRICATING GREASE, long accustomed to annual sales gains, have become increasingly concerned with recent developments, technological and otherwise, which present a threat to the continued increase in the market of their products. In fact, in 1958 NLGI statistics on industry production revealed that 1958 production of lubricating greases was approximately 10 per cent less than the preceding year. It is granted that there are many factors involved in the total demand for lubricating grease. The general level of economic activity must of course affect our industry, as it does others. Nonetheless, some part of the whole depends on developments having no relation to the number of automobiles manufactured or number of acres planted, cultivated and harvested.

Evidence of factors adversely affecting our market is all about us. The radio and television tell us how our automobile can use crankcase oils 4000 miles. The fine print in the owner's manual points out that under less than ideal operating conditions it should be changed more often. But, who reads the fine print? Who knows what ideal operating conditions are—or are not? If the automobile owner doesn't get the crankcase oil changed, he also doesn't get it greased. Fortunately for his own best interests, the automobile owner has his own ideas about how often he should have his automobile lubricated.

Farmers are told to buy a new hay baler and throw away their grease guns. It has "sealed for life" lubricated bearings. Unfortunately, "sealed for life"—or "life time lubricated"—or whatever the phrase, refers to the life of the bearing and not the life of the unit.

The news columns tell us and our customers that in 1960—or 1961—or sometime—the automobile chassis will have no grease fittings. For more precise statistics you are referred to the excellent paper presented to the NPA meeting in Cleveland in April, 1959, by Thomas W. Phelps of Socony Mobil Oil company. The title of Mr. Phelps' paper is "Supply and Demand Prospects for Lubricants."

Paraphrasing Tom Paine—"These are times that try grease manufacturers' souls."

How about it? What *is* the future of the lubricating grease industry? Should we take a more conservative view on capital improvements? Should we delay starting that new salesman in East Overshoe? Should we cut back on advertising and sales promotion and put the money in the bank for that rainy day when we convert our plants to the manufacture of synthetic seaweed?

Obviously, these are questions which must be answered both for ourselves and our stockholders.

It is the purpose of this paper to show that although there are problems which confront us, these problems can be solved. It will require action by each individual company, and also joint action by the many companies in our industry.

Let us consider first what each company can do to improve its individual situation.

Each Company

There is nothing presented here that is new, startling and original. Rather it is intended as a brief review of fundamentals enabling marketers to take stock of their present grease marketing effort. If this industry is to be equal to the challenge, the level of marketing effectiveness must be improved in all its separate parts.

What is necessary is a re-evaluation of the entire grease marketing effort. Always, in time of crisis—or to use a milder word—adversity—men either collapse or are goaded to action, adopt new and revolutionary methods to solve their problems. Arnold Toynbee, the eminent British historian, says that the challenge of

adversity is a prerequisite in the development of a civilization. Our industry has been challenged—we should be grateful for the challenge, and in our response achieve new levels of activity.

Now is the time to assign new values to the many factors in your marketing equation. Perhaps it is even time to develop a new equation.

Let us review what we are doing now and determine how we can improve in an effort to sell more lubricating grease.

The sale of any product depends on a great many factors, if you will forgive an obvious statement. For purposes of review, let us look at some of the larger parts making up the whole.

To Whom Are We Talking?

A marketer must think of his total marketing effort in terms of the consumers who use his product. Often, the consumers have varied and diverse needs. In an effort to find some common denominator for all—some common term of reference—our advertising has become vague, non-specific and meaningless. Instead of saying something to everybody, we end up by saying nothing to anyone. This may be the explanation why the smaller company, aiming at a specific segment of the market, very frequently can outsell its larger competitor in that market, just as David slew Goliath. Goliath's fatal error was his assumption that sheer size and a reliance on formerly successful techniques would decide the issue. The lesson here is inescapable.

Our market ever changes. What was true yesterday, is false today. Marketing assumptions based on yesterday's facts lead to disaster. What must be done is to reappraise the market for our products and find some better way of serving customers' needs.

The first item on our check list then is to restudy, reappraise our market and to direct our advertising to each segment of our market.

How Good Is Our Product?

It would be easy to say that our product is good enough. Tremendous improvements in stability, water insolubility, range of operating temperatures, dispensing characteristics have been made. Yet, when we rest on our oars, the boat doesn't simply stand still; it drifts downstream. We must seek better products, better than the customer thinks he needs and educate him to his need. We've been too much concerned about how cheaply we can satisfy the need and not enough concerned about educating the consumer to be able to recognize how a better product will yield greater benefit to him.

Separate and aside from the performance characteristics of lubricating grease, this industry has been until recently very remis in dramatizing products. Too often the production department has given the sales department a product and told them "Here is it—sell it." The cart is in front of the horse. The sales department should say, "Here is what we can sell—build it."

Emphasis must be placed on giving a product some status, color, life, personality. The public image of lubricating grease is not a happy one for the industry. It doesn't need to be that way. Why not dye grease red as long as it is not implied that wondrous properties are inherent in the product because it is red? People like the colorful, the glamorous. Begin thinking in terms of a Grease Personality Quotient. This is a side issue and a danger lies in it becoming the main sales message, but wisdom and restraint should prevent any problems here.

The second item on the check list is to review the product. Is it good enough? Does the product have personality?

How Attractive Is the Package?

Great progress in more attractive packaging has come about in recent years. Some, however, are still of the old school who believe that the only important thing is the product inside (or the price) and that any effort, time and expense to design a more attractive package is wasted. The consumer *will* finally judge the product on the product's merits. Before he can do this, he must first buy the package and he won't buy unless the package catches his attention. Surely, you can't judge a book by its binding, but most people won't even investigate what's inside unless it catches their eye.

In some markets, packaging is more important than in others. But in no market is it unimportant and a grease marketer would do well to challenge the attractiveness of his containers. Often a new design—just because it is fresh and new—will arouse attention all the way through the marketing chain from the filling line to the consumer.

If designs are so old that one can't remember exactly when they were introduced, it is time to consider new ones. Package design is one area where "do it yourself" does not work. Get expert help. Most container manufacturers can be of some assistance. In most cities there will be found artists who specialize in packaging designs.

But, however it is done—now is the time to begin.

The third item to be reviewed is the fresh appeal of container designs.

Costs

Of all the factors in the marketing equation, none have changed more rapidly than the costs of distribution. These factors include the cost of freight, warehousing, salesmen compensation and training.

The subject is much too broad to consider in any detail here. Suffice it to say then that any re-evalua-

tion of a marketing effort must certainly include a careful review of costs. Depending upon each individual situation, warehousing at distant points may be more desirable or less desirable than formerly. The high cost of LTL or LCL shipments may now suggest radical and complete changes in policy even to the point of plant relocation. Every marketer must include on his check list a careful study of marketing costs.

Sales Training

As new answers to new problems are found, it will be necessary to train personnel in the marketing chain. New people enlisted in the marketing army will require training. Renewed motivation is necessary, particularly so in view of the many discouraging predictions regarding the use of our products. Dealers, jobbers, distributors, salesmen, managers, all must be armed with knowledge of the product and how to sell it.

Additional Products

One of the striking developments which has taken place in American industry since the war is the explosive burst of new products. Virtually every industry has developed new products which now represent a significant portion of business activity. Management in our industry would be guilty of serious error if long range plans and intensive investigations to develop new products were not underway. This must be done to develop more through-put to absorb ever growing overhead. We also must be alert to new product possibilities as a hedge against an uncertain future.

A grease manufacturing plant can be adapted to a wide variety of uses. There are hundreds of products now being marketed outside our industry which could be manufactured without great modification of facilities.

It is of course one thing to state that we should be developing new possibilities and another thing to do it. More than anything else, it will require an alertness and a serious purpose.

Industry Action

Individual companies' increased efforts will yield increased sales for the industry. It is not a matter of each company securing for itself a larger piece of the industry pie. Each company will help build a larger pie for the industry.

Beyond each company's effort lies the opportunity of industry action to solve industry problems. Our industry has already demonstrated the ability of individual companies to work together in solving common problems. The NLGI has a rich history of accomplishment behind it. It has done much to stimulate product improvement.

Why is it not entirely logical that the NLGI—heretofore largely concerned with the technical aspects of our industry—turn its attention to these problems which concern marketing? It will benefit us little to have more efficient mixing kettles and better products if there is no one left to use our products. It is vitally important that we continue our efforts to build better products, but we must also begin to work together to enlarge our market.

How can the lubricating grease industry do this? What is needed? Where do we start?

Marketing Committee

Each company that is a part of the NLGI selects a company representative and a Technical Committee representative. The NLGI should now form a Marketing Committee and each company should select a Marketing Committee representative. Just as the Technical Committee has as its goal the development of better products, the Marketing Committee should have as its goal the enlargement of the market.

The First Job of the Marketing Committee

To solve any problem the first thing that must be done is to identify and describe the problem. As its first responsibility, the Marketing Committee should undertake a program to survey the market and to evaluate the areas in which the best opportunities for increased sales exist. As an example, a survey made of service stations in the Omaha market reveals that 88 per cent of the motorists having the crankcase oil changed, also had their automobile chassis lubricated. This demonstrates that the chassis lubrication market is very closely linked with crankcase oil drain intervals. It also poses the question of what happens to the other 12 per cent who do not have the automobile chassis lubricated. This same survey revealed that service station operators feel that they have virtually no advertising and sales help in convincing the motorist of the need for chassis lubrication.

The Marketing Committee in the development of its program should consider the desirability of more extensive surveys to reveal areas where industry joint actions can be focused.

Development of a Common Theme

To influence the consumer there is little doubt that the advertising programs of individual companies would continue to be the most effective method. The Marketing Committee, however, in spotlighting areas where informational needs exist, might encourage each company to give its advertising attention to these specific areas. If any uniform message describing the need, for example, of chassis lubrication, could be developed, how much more effective it would be for *many* companies to advertise the need!

Another possible function of the Marketing Committee would be to give publicity to devices which make greasing easier to do. Many service stations being built today have no lube racks and hoists. De-

velopment of "bank lubrication" whereby lines from fittings are brought to a common point could make possible the quick, simple, easy lubrication of automobile chassis fittings while the automobile is being fueled. The Marketing Committee, perhaps in co-operation with the Technical Committee, could undertake a program to evaluate new methods of lubrication bringing them forcefully to the attention of equipment manufacturers.

It seems highly desirable that our industry develop a louder voice in speaking to equipment manufacturers. Nobody seems to be listening to us now. For example, the economics of "sealed for life" bearings should be studied, results tabulated and presented to members of the industry for use in discussions with equipment manufacturers.

Public Relations

There is an opportunity for us to present the case for grease lubrication in many magazines of consumer interest. Articles written in the consumer interest could be prepared and sent to publications for use as editorial copy. Many farm papers often use such material for the benefit of their readers. How effective this activity would be would of course depend on its timeliness, degree of consumer interest and its professional preparation. It is obvious that the cost of presenting the industry opinion would be much less, done in this manner, than by buying the same amount of space as an advertiser.

Professional Assistance

It seems highly desirable to enlist professional help early in the activities of a Marketing Committee. There are organizations skilled in public relations and advertising activity. Their advice and counsel could do much to make our joint efforts more effective. Perhaps such assistance already exists within the organization of the NLGI. If not, it should be employed.

The activities of a Marketing Committee would necessarily cost money. A budget should be prepared after an investigation of goals and objectives is made. The budgeted amount could be raised within our membership by a levy made on each pound of grease produced by each participating manufacturer. This is commonly done by other industry groups to finance joint advertising and public relations activities.

Assuming a budget of $25,000 and industry production at 500,000,000 pounds of lubricating grease, quick calculation reveals a levy of only 5/1000 of 1 cent per pound. Surely, if these activities are in any degree effective, it is worth this much to us.

It is not the purpose of this paper to list each and every activity of an NLGI Marketing Committee. The purpose of this paper is only to present the need for a Marketing Committee and in selling the need, suggest activities which make this approach practical. With the aid of the best marketing minds in the industry, a comprehensive program of identifying the problem and suggesting action would be developed.

Many examples of other industries' collective effort to influence users of their products exist. A review of other industry-wide programs would make it appear that the lubricating grease industry is one of the few which does not emphasize industry-wide marketing efforts.

Summary

Difficult problems confront the lubricating grease industry. Their solution depends on the response made by each company acting singly and in concert with others.

Each company must take a new view at each factor in its marketing equation. Status, identity, personality, must be given to products, packaging designs improved, sales promotions made more effective, sales training updated and distribution costs must be closely studied. In short, grease marketing must be made more effective.

The best hope of progress will come as a result of joint industry effort. It is respectfully suggested that the Board of Directors of the National Lubricating Grease Institute give consideration to the establishment of a Marketing Committee. This Committee consisting of a representative from each member company would be subdivided into sub-committees, each with a specific area of study. From the Marketing Committee a plan of action would come whereby the continued growth of this industry might be assured.

Now is the time and here is the place. It is not yet too late. ■

About the Author

J. Y. McCollister *was graduated from the state university of Iowa in 1943. During World War II, he served as radar technical officer aboard the cruiser Birmingham in the Western Pacific. Following his release from active duty, he was employed by International Business Machines Corp. as an accounting machine salesman. In 1953, he resigned his position as special representative to the meat packing industry to become sales manager for United Petroleum Corp. Mr. McCollister is vice-president of McCollister Grease & Oil Corp., and is president of United Petroleum, a marketing subsidiary. He is a former contributor to the NLGI* Spokesman.

100-Plus Ways to Sell More Grease Jobs

As part of its "Help Expand Oil Demand" campaign, the *Oil Daily*, national newspaper of petroleum, worked up the following article on promotion of grease jobs to be published at the time of the NLGI annual meeting in New Orleans. All the material was originated by John Sparks of the *Oil Daily* New York office, while editor Milburn Petty gave the Institute permission to reprint this creative work in the NLGI SPOKESMAN.

By: John Sparks

New York Office

The Oil Daily

Reprinted from the Oil Daily, Oct. 26, 1959

Selling lubrication jobs is the stepchild of the oil industry's efforts to merchandise its automotive servicing. But it is a service that the customer expects from every service station worthy of the name. If lube jobs are neglected—and burned-out bearings result, the customer likely will take his gasoline and oil business elsewhere. Also, remember that once a car is on the lift, the customer is an "easy sell" for TBA items (which will much more than offset the low profit margin on grease jobs). So, the time and extra effort spent to provide complete lubrication is not wasted. Herewith is a listing of more than 100 ways to sell more grease jobs, developed by the *Oil Daily* as part of its "Help Expand Oil Demand" campaign – Editor.

Automotive Appeals

Sell lubrication—it isn't and won't be bought voluntarily.

Sell lubrication—not greases.

Sell lubrication for "longer life—better performance."

Abandon "seasonal" lubrication appeal – sell lubrication on year-around basis.

Stress need of following auto makers' 1,000-mile grease job rec-

ommendation.

Stress comfort of well-lubricated car.

Stress effect of high speeds on poorly lubricated car.

Tie in lubrication with safety.

Appeal to women drivers — good lubrication means better driving, ease of operation, trouble-free driving, more spending money with fewer repairs.

Use billboards particularly for lubrication message.

Research—Laboratory

Combat synthetic lubricants with petroleum greases.

Push development of multi-service greases.

Develop new automatic grease dispensing equipment.

Improve present automatic grease dispensing equipment.

Check new industries and products for new grease uses.

Work with auto firms for more easily serviced grease fittings.

Research—Service Stations

Improve lube bays for quicker and more efficient service.

Make lube bays as efficient as pump islands.

Study present bay inefficiencies, particularly lighting, eliminate them.

Design bays for car handling, grease equipment handling ease.

Make lubricating charts more easily handled.

Make lubricating charts more easily read and followed.

Packaging Research

Make package easy to use for special application.

Provide against grease deterioration from rust, chemical activities of packaged material.

Make package leakproof despite frequent use.

Provide small size packages for special greases for appliances and other household uses.

Fit package size to amount of lubricant commonly purchased or used for easy marketability.

Make package easily resealed to prevent deterioration of unused portion of grease.

Selling lubrication is not a sought-after job—rather, one that must be done. Point out that good lubrication is vital to the proper operation of vehicles.

Industrial Sales

Sell need of fixed lubrication responsibility, supervision.

Raise lubrication to major item of plant maintenance.

Make plant lubrication buying easy with complete program.

Sell lubrication as major factor in cost control.

Show lubrication means reduced parts inventory.

Tie in lubrication with fewer parts replacement.

Sell lubrication on more man-hours per machine.

Lubrication prevents costly machine downtime, output loss.

Lubrication prevents rust, corrosion of idle machines.

Tie lubrication with smaller grease inventories, purchasing costs cut.

Tie in lubrication with plant safety program.

Work out combined inventory, lubricating program.

Governmental Units

Although nearly all governmental units buy petroleum products by competitive bidding it does not follow that all vehicles are properly serviced.

Industry should seek to fix lubrication responsibility and supervision for all publicly owned fleets of vehicles.

Winners of competitive bids should seek to set up lubrication schedules for all units furnished with products.

Aid should be given in obtaining proper lubrication charts for vehicles owned.

Aid should be given in obtaining proper grease dispensing equipment.

The 1,000-mile lubrication schedule should be sold on basis of hard

use of vehicles.

Better public service and public safety are selling points.

Post Office truck fleets should be surveyed for proper maintenance.

States—

Highway maintenance department vehicles.

State police car fleets.

Municipalities—

Street maintenance equipment.

Police car fleet.

Fire departments.

Power plants, water works, bus fleets, other transportation systems.

City-owned airports.

Other Industrial Sales

Sell private airports, flying schools, lubrication as safety measure.

Sell flying schools for "moth-balling" in non-flying seasons.

Survey isolated manufacturing plants for lubrication programs.

Oil well drilling contractors use many kinds of grease.

Sell lubrication service to department store delivery fleets.

Sell lubrication service to parcel delivery fleets.

Sell school bus fleets on lubrication for safety.

Agricultural Sales

Advertise in farm magazines and weekly newspapers.

Sell lubrication at Grange and all other farm meetings.

Set up exhibits at county fairs.

Hold lubrication demonstrations for farm machinery at farm meetings.

Hold lubrication demonstrations at county fairs.

Work out lubrication charts for farm machinery.

Work with farm machinery, tractor firms for lubrication programs.

Sell lubrication to 4-H clubs and Future Farmers of America.

Work out inventory for farmers for all grease uses.

Tie in grease sales with sale of other petroleum products.

Work out grease dispensing equipment for servicing by farmer.

Work out servicing contract by year with farmer, planter.

Stock necessary greases for planting, harvesting seasons.

Distributors should offer special services during planting, harvesting periods.

Stress how unlubricated equipment may result in crop loss.

Help farmer prepare equipment for winter storage.

Millions of pieces of huge equipment in highway construction, construction industries, coal mines, quarries offer biggest growth field for greases.

Highway construction program has been a huge market for many years.

Simplify lubrication plans for minimum grease stocks at job site.

Assure proper equipment for dispensing lubricants.

Supply proper manufacturer lube charts.

Prepare lubrication program for year-around use of equipment.

Stress effect of equipment on contract deadline.

Prepare complete lubrication program for all equipment owned by contractors.

Offer to service equipment at weekends with mobile equipment when vehicles not in use.

Counsel with maintenance superintendent on his special needs.

Alert company representatives when contractor moves.

Ascertain where his next job will be and have company representative meet him and continue service program.

Railroads

Longer trains, faster schedules make good lubrication even more a "must."

Tower electronic dispatching emphasizes need of good lubrication.

Switch lubrication should be tied in with use of heaters.

Inside curve grease is being studied by industry.

Make continuous survey of railway grease needs.

Stress how equipment breakdown offsets long-haul diesel engines.

Develop greases to meet new heavy-duty demand on long, fast trains.

Develop greases for seasonal use for special equipment.

Cooperate on program as grease needs change with equipment, use.

Service Stations

Upgrade "step-child" status of chassis greasing.

Put real service man in charge of chassis jobs.

Train at least one man – two is better–for lubrication duties.

Stress clean uniforms to keep car clean while servicing.

Clean out lube bays and make attractive and efficient.

Divorce bays from repair department.

Make lube bays available on customer's arrival.

Write legibly on door jamb sticker.

Put complete grease record on door jamb sticker.

Clean off all but current sticker on jamb.

Deliver car after servicing.

Check second-hand car lot in vicinity for prospective customers.

Offer every buyer off lot a free lube job with tie-in sale.

Distribute handbills at nearby motels.

Visit transient trailer camps for trailer, car servicing.

Tie in grease jobs with gasoline sales.

Tie in grease jobs with oil changes.

Keep accurate station grease record of regular customers.

Notify customer by phone or postcard when you think grease job due.

Check door jamb sticker when customer drives into station.

Advertise lubrication demonstration on weekends.

Tie in lube job with TBA sales.

Sell a year's 1,000-mile grease jobs at reduced price.

Give prize to employee selling most jobs.

Tie lube jobs in with all station sales.

Give bonus trading stamps (if you use them) to boost grease jobs.

Organize bays for fast, efficient jobs. ■

NLGI TECHNICAL COMMITTEE ORGANIZATION

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Standard Oil Company (Indiana)

M. J. Poharilla, *Vice-Chairman*
Kendall Refining Company

M. L. Carter, *Vice-Chairman*
Southwest Grease & Oil Company

L. C. BRUNSTRUM

M. J. POHORILLA

M. L. CARTER

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T. D. Kay	Sunland Refining Corporation
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R. P. Lee	Consumers Cooperative Association
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L. S. Thornes	British Petroleum Company, Ltd.
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J. P. Pardo	Sta-Vis Oil Company
I. R. Slingerland	United Co-op., Inc.
L. S. Thornes	British Petroleum Company, Ltd.
H. C. Zweifel	Richfield Oil Corporation

J. J. DICKASON

Continued on next page

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T. D. Kay	Sunland Refinery Corporation
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R. P. Lee	Consumers Cooperative Association
K. P. Powers	Gulf Research & Dev. Company
H. C. Zweifel	Richfield Oil Corporation

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SUBCOMMITTEE ON RECOMMENDED PRACTICES

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The Pure Oil Company

(In process of reorganization)

SUBCOMMITTEE ON MANUAL OF TEST METHODS & DEFINITIONS OF TERMS PECULIAR TO THE LUBRICATING GREASE INDUSTRY

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J. J. Dickason	Jesco Lubricants Company
H. U. Fisher	California-Texas Oil Company
E. M. Higgins	Master Lubricants Company
C. E. Hulme	Kendall Refining Company
J. D. Smith	International Lubricant Corp.

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GEORGE ENTWISTLE

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AUTOMATIC TRANSMISSION FLUIDS

Literature and Patent Abstracts

Composition

Copolymers of Propylene and Piperylene as Grease Thickeners

Certain copolymers of propylene and piperylene have been found useful as thickeners in lubricating greases, according to Morway, Seelbach and Cottle (U.S. Patent 2,901,432, assigned to Esso Research and Engineering Co.). The most desirable copolymers are those having molecular weights of 1,000 to 500,000 which contain 1 to 50 weight per cent of piperylene and 99 to 50 weight per cent propylene. Such copolymers are prepared at low pressures in the presence of a catalyst consisting of a reducing metal compound and a reducible metal compound.

For example a catalyst was prepared in a nitrogen atmosphere by mixing 10 ml. of a 0.169 molar solution of titanium tetrachloride in dry n-heptane and 20 ml. of a 0.253 molar solution of aluminum triethyl in dry n-heptane. A black precipitate formed which was added to a 300 ml. stainless steel bomb into which was injected a cold mixture of 7 grams of piperylene and 70 grams of liquid propylene with 50 ml. of heptane. The closed reactor pressure was raised to 400 psi and the contents were heated to 80°C. for over a period of 2 hours and maintained at this temperature for 90 hours. After cooling the bomb to 30°C. it was opened, filled with isopropanol and the contents filtered to give the copolymer which was further washed with isopropanol and dried first on a steam bath and next in a vacuum at 70°C. This gave 36.4 grams of a tan granular solid having a molecular weight of 43,000.

Ten per cent of the above copolymer was added to 90 per cent of a napthenic type lubricating oil having a viscosity of 55 SUS at 210°F. This mixture was heated to 370°F. and maintained there for 30

minutes while agitating. The mixture was then allowed to cool to room temperature without further agitation. The resulting lubricating grease was a smooth product with an unworked penetration of 250, worked penetration of 275 which changed to 280 after 100,000 strokes. The dropping point of the lubricant was 220°F. and it was insoluble in water. Five per cent of the thickener formed a lubricating grease with a worked penetration of 370 and a dropping point of 180°F.

Lubricating Greases Thickened with Metal Salts of Sulfonated Hydroxy Azo Compounds

According to Odell and Lyons (U.S. Patent 2,908,644, assigned to Texaco Inc.) lubricating fluids are thickened with 5 to 45 per cent of high melting monoazo compounds to form lubricating greases. The preferred pigments consist of polyvalent metal salts of sulfonated benzene-azo-naphthol compounds and naphthalene-azo-naphthol compounds in the form of particles below 5 microns in diameter. The pigments may be employed as extended toners in which a certain amount of alumina, titania, etc., is present or in a resinated form obtained by co-precipitating resin soap and dye by means of a polyvalent metal compound.

A typical lubricating grease was formed by using 30 per cent of a pigment known as Persian Orange (prepared by precipitating 4-(2′-hydroxy-1′-naphthylazo) benzenesulfonic acid upon aluminum hydrate) with a naphthenic oil of 330 viscosity SUS at 100°F. After the oil and pigment were mixed, the mass was given two passes through a Premier colloid mill at 0.002-inch clearance. This gave a No. 1 NLGI grade of lubricating grease having a battery texture and a dropping point above 500°F. While this product had excellent oxidation resistance in some cases oxidation inhibitors are added in which case they are dissolved in three times their weight of tricresyl phosphate before addition to the mixture.

Stabilizer and Anti-Oxidant for Sodium Base Lubricating Greases

A combined structure stabilizer and anti-oxidant for sodium base lubricating greases consists of the condensation product of ethylene oxide with aromatic amines or amides. These additives do not adversely color or give odors to the lubricant in which they are used. According to Bidault and Metenier (U.S. Patent 2,903,427, assigned to Esso Standard Societe Anonyme Francaise) the preferred amount of the additive is 0.1 to 2 per cent by weight of the lubricating grease.

Thus, a mixture of 15 per cent stearic acid, 2.45 per cent sodium hydroxide and 82.55 per cent of a mineral oil having a viscosity of 150 SUS at 100°F. and a 115 VI

was heated to 400°F. and pan cooled before milling. One per cent of a substance obtained by condensing 1 mol. of phenyl alpha naphthylamine with 5 mols. of ethylene oxide was added to the above lubricating grease to form a product having a worked penetration of 193, a dropping point of 370°F., an oil separation of 0.4 per cent in a wire cone at 212°F. in 50 hours, and an Oxidation test of 400 hours in a Norma-Hoffman bomb.

Blended Lithium Calcium Base Lubricating Greases

By blending 40 to 80 per cent of certain calcium soap-salt thickened lubricating greases with 20 to 60 per cent of lithium base lubricating greases, the water-resistant ability of the first component is improved and the lubricating life of the second component is benefited.

Morway in U.S. Patent 2,908,645 (assigned to Esso Research and Engineering Co.) illustrates these points as follows. Grease G was prepared from 15 per cent glacial acetic acid, 3.6 per cent caprylic acid, 11.1 per cent hydrated lime, 0.5 per cent phenyl alpha naphthylamine and 69.8 per cent of a mineral oil having a viscosity of 55 SUS at 210°F. Grease H was made from 12 per cent methyl 12-hydroxy stearate, 1.68 per cent lithium monohydrate, 0.5 per cent phenyl alpha naphthylamine and 85.82 per cent of the above oil. G alone when mixed with 10 per cent of water and subjected to 1,000 strokes in an ASTM Worker fluidized. A mixture of equal amounts of G and H after the same treatment had a penetration of 242. Also, while G had a lubricating life (details of test not given) of 651 hours, the 50/50 mixture did not fail at 2,500 hours when the test was stopped.

Lubricating Greases Containing Polymerized Dihydroquinolines

Lubricating greases, in which the thickener is sodium myristate, are improved by stabilizing the gel structure if 0.1 to 10 per cent of polymerized 2,2,4-trimethyl-1,2-di-

hydroquinoline is added to the composition. Use of this additive is stated by Roach and Dilworth (U.S. Patent 2,908,646, assigned to Texaco Inc.) to increase yields, improve texture and permit exceptionally high temperature performance. The polymer may be added at any stage of processing when the temperature of the mixture is above the melting point of the additive.

For example, myristic acid was saponified with an excess of sodium hydroxide using an oil blend of 55 parts of a 120 viscosity SUS at 210°F. and 10 parts of an SAE 20 grade. A small amount of the oil was used during the formation of the soap and dehydration of the mixture, the latter step being conducted at 295 to 320°F. The remainder of the oil was added during cooling and the polymer added when the temperature was about 240°F.

The finished lubricant contained 15.5 per cent of soap and 3 per cent of trimethyldihydroquinoline polymer. The dropping point of the product was 400°F. In a high temperature performance test at 300°F., the lubricating grease failed after 1492 hours.

Gear Lubricants

Adhesive Lubricants for Open Gears, Wire Ropes, Etc.

According to Cook and Cortiss (U.S. Patent 2,910,440 assigned to the Pure Oil Co.) open gear and wire rope lubricants which are quite tacky yet fluid are formed if 1 to 15 per cent by weight of polymerized methyl esters of rosin are added to viscous residual oils. These viscous oils may be the extracts from solvent refining of lubricating oils. Residual asphalts may also be included in the compositions. A satisfactory polymerized methyl ester of rosin is "Polymerized Abalyn, Dark" which has a molecular weight of 760, a melting point of 212°F. and an acid number of 15.

The suggested lubricants may be prepared with widely varying viscosities as shown in the following table:

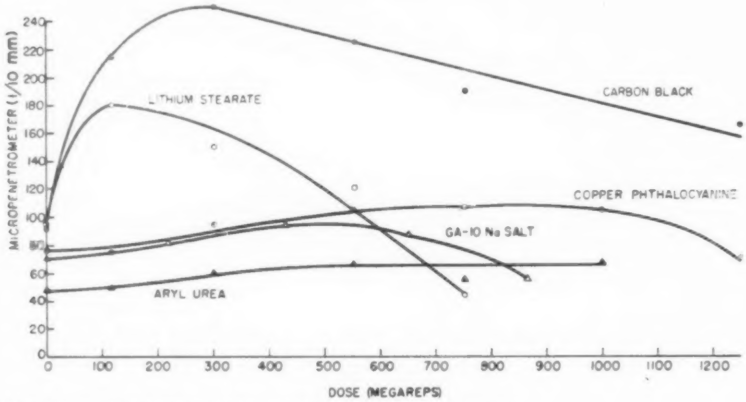
Component by Weight per cent					
Polymerized methyl ester of rosin	12.0	12.0	12.0	12.0	12.0
Neutral solvent-extract	6.5	...	...	...	...
Bright stock extract	81.5	75.0	57.0	49.0	40.0
Asphalt (softening point, R&B°F 197)	...	13.0	31.0	39.0	48.0
Physical properties					
Gravity °API	10.2	9.9	8.9	8.5	7.9
Viscosity at 210°F. SUS	501	1016	1974	2991	5144
Pour Point °F	+60	+75	+85	+90	+95

Application

Radiation Stability of Silicone Greases

D. J. Fischer, J. F. Zack, Jr. and E. L. Warrick, *Lubrication Engineering* 15, p. 407-9 (1959).

First the inherent stability of silicone fluids to radiation was determined by gas evolution and it was found that such fluids with higher aromatic content are most radiation resistant. Next, the thickener employed also influences the stability of the system. This is shown graphically in the accompanying graphs. Here it is evident that carbon black or lithium stearate are unsatisfactory for radiation resistant greases but that copper phthalocyanine, GA-10 sodium salt or aryl urea are satisfactory thickeners for the purpose.



The filler effect in radiation resistance of 710 greases.

Gear Lubrication

Modern Techniques for Spray Lubricating Industrial Gearing

E. J. Gesdorf, *Lubrication Engineering*, 15, p. 398-402, 409, 410 (1959).

This article is devoted primarily to a description of the development of methods and equipment for properly spraying industrial gears. Mention is made of the fact that the quantity of lubricant applied in the field varies from 80 per cent below to 566 per cent above AGMA recommended quantity.

One steel plant is stated to be using a lithium soap base grease to spray 65 points on a mill table, 38 of which are table roll and line shaft bearings and the remaining 27 points open gearing. This system cycles once per hour and uses 1.6 pounds of lubricant per eight-hour operating turn. With a more effective lubricating job, the above grease replaced 38.4 pounds of gear lubricant and 2 gallons of oil per shift.

Industry News

ASLE Annual Meeting Set For April in Cincinnati

The fifteenth annual meeting and lubrication exhibit of the American Society of Lubrication Engineers will be held in Cincinnati, Ohio, at the Netherland Hilton hotel on April 19, 20 and 21, 1960.

More than 2,000 top industrial executives and lubrication engineers are expected to attend this meeting, to hear more than 50 top-flight lubrication experts scheduled to speak during the three-day event.

European interest in the ASLE annual meeting program will be demonstrated by papers contributed from England, Germany, Sweden and the USSR.

The annual course in lubrication engineering will be held concurrently with the technical sessions and the highlight of this course will be a tour of the Cincinnati Milling Machine company, with emphasis on lubrication applications.

Rieke Builds Office and Warehouse in Linden, N. J.

Rieke Metal Products corporation, headquartered at Auburn, Indiana, will erect a modern one-story air conditioned regional office and warehouse building on a large tract of land recently acquired at Industrial lane and Commerce road, west of and visible to Route 1, in Linden, New Jersey, according to an announcement by Glenn T. Rieke, president. The project, scheduled for completion early next spring, is the initial eastern warehouse operation for Rieke. New manufacturing plants were erected by the company in recent years near Toronto, Ontario and in Mexico City. Other regional sales offices are in Oakland, California; Houston, Texas; Philadelphia, Chicago and New York.

Established in 1921, the Rieke company is one of the leading manufacturers of metal and plastic closures and cap seals for drums and containers. Oil, chemical and paint companies are principal users.

The decision to locate in the Linden industrial area resulted from a detailed survey and study of dis-

tance and time factors, for the convenience of and proximity to drum and container manufacturers along the eastern seaboard.

Morway Commended on Issuance of 200th Patent

A. J. Morway, Esso Research and Engineering company, Linden, N. J., was commended in February by Robert C. Watson, U. S. commissioner of patents, on issuance of the 200th patent to Morway. This patent makes Morway one of the nation's most prolific inventors and sets a record in the 40-year history of Esso Research.

The new patent, issued February 1, opens possible new applications for an already highly versatile lubricating grease known as Nebula EP, widely used in industrial and automotive applications.

Morway, first employee of Esso Research to obtain 100 and 150 patents, joined the company in 1929 and received his first patent in 1939. He was made a research associate in 1957 in recognition of his services. (In an early issue of the NLGI SPOKESMAN, the journal will present a paper authored by Morway and J. J. Kolfenbach.)

ASA Publishes Petroleum Container Standard

American Standard Dimensions for Shipping Cases for Petroleum Containers, MH7 . 1-1959, has just been published by the American Standards association. Covering thirteen of the most commonly used shipping cases, the recommended case sizes are based on the assumption that the containers packed in them conform to the following standards:

American Standard Specifications for One-Quart Round Motor Oil Cans, MH3 . 1-1954 (formerly B-64 . 1-1954); American Standard Requirements for Five-Quart and One-Gallon Round Motor Oil Cans, MH3 . 2-1957 (formerly B64 . 2-1957); and American Standard Requirements for Oblong Oil Cans, MH3 . 3-1954 (formerly B64 . 3-1954). (*Continued on page 502*)

In a number of instances, the same nominal size shipping case is used in two different ways. The empty case may be received at the packaging plant in a flat condition (knocked down), and must be assembled (set up) prior to packing. Such cases are designated as shipper cases. The empty case may also be received at the packaging plant in the set up condition and filled with empty cans. In this instance, the cases are designated as reshipper cases.

Each case considered was thoroughly tested by large production runs before recommended sizes were approved.

The American Standards association is the national clearinghouse and coordinating body for standardization. It is a federation of 122 national trade associations, professional societies and consumer groups, with some 2,000 company members.

American Standard Dimensions for Shipping Cases for Petroleum Containers, MH7 . 1-1959, is available at 35c a copy from the American Standards association, Dept. PR114, 70 East 45th St., New York 17, N. Y.

Carrier Claims Tests Reduce Truck Wear

Killion Motor Express, Louisville, Kentucky, reports that it has compiled statistical evidence of reduced wear on its fleet of trucks as a result of using "Moly" chassis grease, according to Climax Molybdenum company officials. This new concept in lubrication is claimed to have resulted in significant savings on parts replacement and repairs as well as other important benefits.

A common carrier operating throughout Kentucky, Illinois, Indiana, Missouri, and Tennessee, Killion first used "Moly" grease on six tractor units which had posed particular maintenance problems. Results were so good in ending drivers' complaints about poor functioning of fifth wheels and in increasing life of parts, that before long the new lubricant — supplied by Standard Oil company of Kentucky — was adopted for the complete fleet.

New Double-Action Lever-Type Grease Gun

A new lever-type grease gun that provides either high pressure or volume delivery of lubricant by means of a simple shifting device has been developed by Lincoln Engineering company of St. Louis.

To change pressure ratios it is only necessary to shift a latch pin in the handle from one slot to another. Manufacturer stated that pressures up to 10,000 p.s.i. can be achieved in the high pressure position, and full pressure can be obtained with a stroke length as small as ¼ inch to facilitate working in close quarters.

The Lincoln gun incorporates a unique nozzle extension that swivels 360° permitting easy access to hard-to-reach fittings. Equipped with hand-fitting, grease resistant rubber pistol grip.

Gun is of all steel construction with rust-resistant, high satin finish nickel plating. It can be loaded three ways; with standard 14½ oz. grease cartridge, with Lincoln filler pump, or by suction. Overall length is 20 inches with a barrel diameter of 2¼ inches.

For additional information and prices on these new items write for Bulletin No. 230, Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.

People in the Industry

Battenfeld Announces Appointment

Battenfeld Grease & Oil corporation of Kansas City has recently announced the appointment of Harold (Hollie) T. Holland as a company representative.

Holland joined Battenfeld December 1 and has completed an extensive company-training program. This training further supplements his 24 years' experience in the lubricants field, during which time he has held positions with various leading independents and refiners, including W. H. Barber, Calumet Refining and Elk Refining.

At the present time, "Hollie" is carrying out assigned duties as a general representative in the lubricants division.

American Potash Names Director of Manufacturing

Calvin L. Dickinson has been named director of manufacturing for American Potash & Chemical corporation plants at Trona, Calif., and Henderson, Nev., it has been announced by Parker S. Dunn, vice president, manufacturing.

The change expands Dickinson's duties to include responsibility for the Henderson plant as well as for the Trona plant where he has headed operations since 1955.

Henry S. Curtis continues as Henderson plant manager reporting to Dickinson, who will continue to make his headquarters at Trona.

H. N. Eldridge

Harry N. Eldridge, retired purchasing agent of Fiske Brothers Refining company, died January 16 at his home in Tenafly, N. J. Mr. Eldridge had been associated with Fiske for 37 years, prior to his retirement on April 1, 1959.

Royal Lubricants Company Makes Executive Promotions

Mr. William Graessle, president of Royal Lubricants company, has announced two executive promotions, effective January 1, 1960. The announcement was made following an earlier meeting of the board of directors.

The two promotions are James C. Mosteller from vice-president of research and development to executive vice-president; and Oliver M. Ballentine from chief chemist, to vice-president of research and development.

Mr. Mosteller joined Royal in 1955, as vice-president and technical director. Prior to this, he was employed as Director of USAF fluids and lubricants research, Wright Air Development center, Research and Development command. He is the firm's Representative to the NLGI.

Mr. Ballentine joined the staff in 1955 as chief chemist. Formerly he was employed by the USAF, Wright Air Development center, as senior research chemist in charge of hydraulic fluid research and the development of radiation-stable lubricants.

Royal Lubricants company manufactures a complete line of aircraft hydraulic fluids, greases and lubricating oils. In addition to these specialized extreme low and high temperature aircraft fluids and lubricants, the firms manufactures special-purpose hydraulic fluids, greases, corrosion preventives and lubricating oils for missiles, tanks, and automotive and marine applications.

A recent development now being utilized in supersonic aircraft and missiles, is ultra clean hydraulic fluids. Such fluids are now being produced from which submicronic particles of dust, dirt etc., even smaller than bacteria are being removed from the fluid. Such cleanliness requires that personnel packaging the fluid, work in an atmosphere completely void of dust and dirt. Personnel are required to take air showers, prior to entering the production area and must wear special lint-free clothes and shoes.

Current research efforts are being concentrated on the development of missile and supersonic aircraft hydraulic fluids, greases and engine oils for use at temperatures of from 500°F to 1000°F.

Emery Adds to Organic Chemical Sales Staff

L. Paul Dougherty and Jack Doyle have been added to the organic chemical sales staff of Emery Industries, Inc., according to R. F. Brown, organic chemical sales manager. Mr. Dougherty will be assigned to the New England sales territory, while Mr. Doyle will cover a territory that includes West Virginia, southeastern Ohio, western Pennsylvania and western New York State.

They will be responsible for the sale of Emerox azelaic acid, Empol dimer and trimer acids, Emfac pelargonic acid, plastolein plasticizers, Emolein lubricant esters, metholene fatty esters, and Twitchell soluble oil bases and fat splitting reagent.

Mr. Dougherty succeeds Walter R. Paris, who resigned earlier this year to study law at Boston university. A native of Pittsburgh, Dougherty is a graduate of Duquesne university where he majored in chemistry.

Prior to joining Emery, he was associated with Hagan Chemicals & Controls, Inc., as a chemical sales representative, and with the American Window Glass company, as a production chemist. He will make his headquarters at Emery's Boston office.

Mr. Doyle, who lives at Pittsburgh, also is a native of that city. He received his B.S. degree in chemistry from the University of Pittsburgh. He has previously been associated with the Bowman Steel company, Resolite corporation, and Rockwell Spring and Axle Co.

Shell Names F. W. Spooner Manager of National Sales

Shell Oil company has announced the appointment of F. W. Spooner as manager of the firm's national sales department. Mr. Spooner assumed his new duties Jan. 1, 1960. He has been assistant to the national sales manager since 1957.

National sales is a marketing liaison group, coordinating the sales of fuels, lubricants and other petroleum products to accounts whose activities cross Shell marketing boundaries. National sales was recently made part of the products and commercial sales department in a realignment of the company's marketing organization.

In April, 1947, Mr. Spooner was named head office representative in the lubricants department. Subsequently, he served as district manager in the Minneapolis and Cleveland divisions, and sales manager in the Sacramento division. He moved from this position to that of assistant to the manager of national sales in April, 1957.